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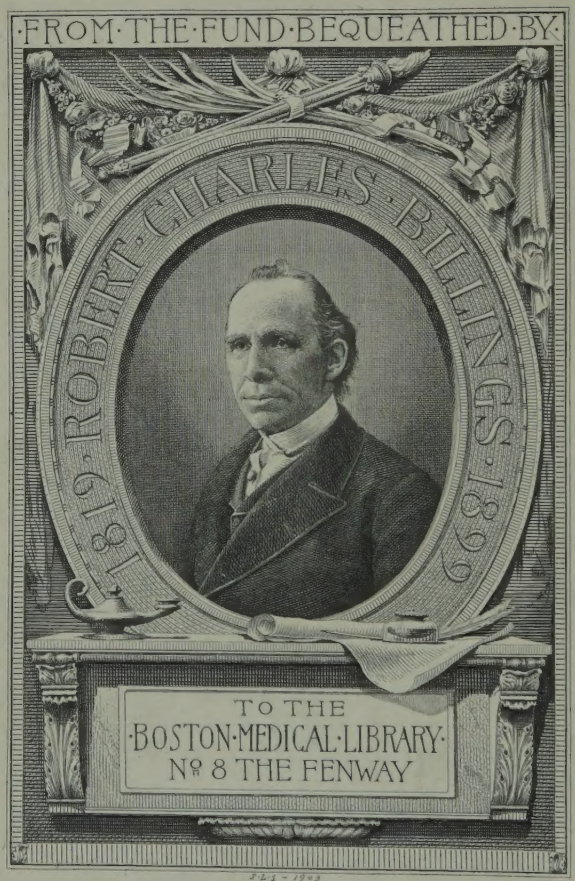
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A MANUAL OF PRACTICAL ANATOMY

A MANUAL OF
PRACTICAL ANATOMY

A GUIDE TO THE DISSECTION OF THE HUMAN BODY

BY

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IN THREE PARTS

PART I.—THE UPPER AND LOWER LIMBS

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PREFACE

THE preparation of a manual of practical anatomy on the lines followed in this book was undertaken at my suggestion, and primarily for the use of our own students, by Professor Walmsley, when he was lecturer in my department in the University of Glasgow.

It is more important that the student, while at work in the dissecting room, should learn to recognise and mentally relate structures, than that he should memorise facts about them. His practical manual should therefore be, in the first place, a directory of dissection. But he requires also the aid of descriptions, which, studied beside the subject, will form a guide to his personal observations. These should be short and concise, always from the point of view of the dissector at work on the part, and restricted to what an intelligent student may be expected to observe for himself.

In this book, accordingly, the general directions are printed in larger type than the descriptive matter, with the view of reversing the emphasis as given in the ordinary practical manual. The figures are simple and schematic, introduced not as pictures of dissections, but as aids to observation. As a further aim of the book it may be stated that the attempt has been made, and I think, as far as the work has gone, with some success, to present to the student the sort of knowledge he should aim at acquiring, and the amount that may be expected of him. It is not intended that the manual should replace the systematic text-book. This should be used as a book of reference, and for the study of points or of systems which

cannot be fully or satisfactorily studied in the dissecting room, and for which, in my own scheme of teaching, the lecture is reserved. As the systematic book is used away from the subject, the student will find that figures with some degree of realistic treatment will further help in what should be his great aim, namely, so to visualise the structures in their relations to one another, that he can find his way about the body with some degree of assurance.

THOMAS H. BRYCE,
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A Manual of Practical Anatomy

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INTRODUCTION

Practical Anatomy, in the sense used here, implies the study of Human Anatomy by the dissection of the dead body. The aim of this book, then, is to direct the student in his work of dissection of the body, and in such a manner, it is hoped, as to induce him to compile for himself a knowledge of its structure by personal observations. It is intended to preclude the use of a systematic text-book in the dissecting room, and contains, therefore, direct references only to those parts of the body which the student is expected to be able to dissect for himself. The diagrams are simple line drawings, and the student will find it an exercise of value to colour appropriately the different tissues.

It should be kept constantly in mind by the student that there are three objects in view as the purposes of practical anatomy:—

1. The impression on the memory of the facts of naked-eye anatomy.
2. The education of the senses of sight and touch in the knowledge of the several structures of the body, and especially of those parts more commonly concerned in disease processes and in surgical operations.
3. The education of the hands in the use of instruments.

The manual part of dissection will be taught to the student throughout his course, and he will be shown the manner of handling the instruments of dissection and directed as to the methods employed in its processes. He should remember that in the practice of his profession he will be called upon to operate on the living body, and a true preparation for this task is careful and

thoughtful dissection. He is expected to provide himself with a case containing scalpels, forceps, scissors, chain hooks, and a probe, the other requisite instruments being provided in the dissecting room.

The manual part of dissection, however, is only part of the student's duty, and is of little real permanent value unless at the same time he studies the anatomical description of the region on which he is engaged. He should refer to a systematic text-book for a complete description of each structure he meets in his dissection, and at the body, comparing his own observations with those of anatomists: he should impress the facts of the description on his memory. His observations he should record for himself before he quits his dissection by means of written notes and sketches of what he sees before him, a habit he will find invaluable for the purpose of revision and of more than mere anatomical advantage in after life. The education of his senses and the cultivation of the faculty of individual observation—the ultimate aims of scientific training—are gradual and imperceptible processes, but are certain to be accomplished if the student do but use his hands properly, and continually make use of the opportunities presented to him in his dissecting room curriculum. He should aim at "knowing" the major part of his anatomy from the dissections he has done.

The Order of Dissection.—The dissection of the body is conveniently divided into four parts: these are, the upper limb, the lower limb, the head and neck, and the thorax and abdomen. At least two, but preferably three days should be devoted to the dissection of the perinæum before the other dissections are commenced, since the anatomy of this region cannot be so well appreciated in any other position as in that of perinæal lithotomy. The dissection of the superficial parts of the face and the anterior part of the scalp can be conveniently carried out during this time. After the dissection of the perinæum, the subject should be laid on its face for the dissection of the hinder parts of the scalp and neck; the muscles and other structures of the back; the buttock, the back of the thigh, and, in some cases, the popliteal space. These dissections may be completed in six days, after which the subject should be turned and the dissectors of the abdomen commence the dissection of the abdominal wall. A time table, which has been found to work to advantage, is prefixed to the description of each part. It should be further mentioned that no student need ever be idle at the times when it unavoidably happens that

he cannot pursue his own dissection, for he can always be learning from the dissections of others without incommoding them at work.

For the student commencing anatomy a few introductory words regarding the structures met with in the course of dissection will not be out of place.

Surface Anatomy.—Before beginning the dissection of each region the student should make himself fully acquainted with the details of its external form, with the precise positions and relations of its bony prominences, and be able to indicate on the surface, as "surface markings," the position and outline of the more important deeper lying structures.

Skin.—The skin consists of two principal layers, a superficial layer—the scarf-skin or epidermis, and a deeper layer—the true skin or dermis. In the dead body the epidermis is usually easily separated. In removing the skin, the incisions should be made at once through its whole thickness, and a corner being held with the forceps the knife is to be carried beneath it, the edge being towards the skin, and the back to the fascia; and as soon as a sufficient area is reflected, the skin should be held and rendered taut with the hand, and the reflection completed along a convexly curved line. The under surface of skin, neatly reflected, is white, and the tissue beneath it—the superficial fascia—should be left smooth and uniform.

Superficial Fascia.—The superficial fascia consists of loose fibrous tissue containing more or less fat, and forms a general investment of the whole body. It contains the superficial blood vessels, nerves, and lymphatics. After securing the superficial nerves and the lymphatic glands it may contain, it should be removed, as far as possible, in one piece.

Deep Fascia.—The deep fascia is a more or less dense membranous structure, lying beneath the superficial fascia. It closely invests the underlying muscles, and sends inwards between them deep intermuscular processes or septa, some of which are attached to the bones. It forms, therefore, sheaths for the muscles, and even gives attachment to muscle fibres. In certain parts of the body the deep fascia is thickened to form well defined bands, which are usually termed "ligaments."

Muscles.—Most of the muscles are attached at either end to bone, and that attachment which is usually the more stationary in the movement caused by its contraction is termed the **origin** of the muscle; the other attachment is the **insertion**. In "cleaning" a

muscle—that is, in removing the investment of deep fascia—it is essential that the fibres should, whenever possible, be made tense by appropriate movement of the attachments of the muscle. A muscle should invariably be cleaned along its fibres, the dissector beginning at one edge and advancing steadily to the other, and thus reflecting in a complete layer the deep fascia from the whole surface. The knife is to be held with the back to the muscle to avoid injury to it. It is most essential, and requires to be emphasised repeatedly, that the borders of a muscle should be accurately defined, and that its attachments should be fully dissected out and, as soon afterwards as possible, studied on the dried bones. A muscle should be divided, when necessary, midway between its origin and insertion, unless when specially directed otherwise, so that these parts may be preserved for further reference.

Arteries.—The arteries are elastic-walled vessels, and distribute the blood from the heart throughout the body. They are usually injected and rendered rigid in the subject, as it is impossible to follow out the smaller branches without this assistance. The main vessels are placed deeply in the different parts of the body, and in the limbs occupy inter-muscular intervals.

Veins.—The veins are the blood vessels which return the blood from the body to the heart. They may be grouped in superficial and deep sets, the former running in the superficial fascia, and the latter accompanying the arteries. The two sets of vessels are united by connecting branches. Nearly all the arteries of the limbs are accompanied by paired veins (venæ comites), but in the head and neck, and thorax and abdomen the veins are usually single, and in some cases do not lie in close relation with the arteries.

Lymphatics.—The lymphatic vessels as a rule accompany the veins, and, like the latter, form two groups, superficial and deep, which communicate through the deep fascia. It is not possible, without special injection, to dissect lymphatic vessels, so that the attention of the student should be directed to the arrangement of the lymphatic glands; but these should be associated, by reference, with the areas of the body they drain and with their further connections.

Nerves.—The main trunks of the nerves and their principal branches are readily followed out, but their minute ramifications require more time and labour for their dissection than a student can usually afford to bestow upon them. Nerves should always be considered or analysed in terms of the direction of their conduction, *i.e.*, as "sensory" or "motor," though most nerves contain both

kinds of fibres, and are called "mixed." The areas of distribution of the sensory fibres, and the muscles supplied by the motor fibres should form an integral part of the study of nerves.

Bones.—The separate and dried bones must be referred to frequently in the course of the dissection, as it is only in this way that the origins of the muscles, and the attachments and relations of fasciæ, ligaments, and other structures, can be properly understood.

In order to preserve a part, and to prevent it becoming dry and hard, it is necessary that, when laying it aside, the dissector should secure the skin around it with a few stitches, and cover it with a damp cloth and a piece of waterproof sheeting.

THE UPPER LIMB

The order of dissection recommended for the upper limb is detailed below, and indicated in brackets is the number of days[1] students should allot to each region.

1. The body is placed in the lithotomy position: no dissection is carried out (3).

2. The body is placed face downwards: dissection of the superficial parts of the **region of the back** (4).

3. The body is placed on its back: dissection of the **pectoral region**: **axilla**: removal of the arm from the trunk (8).

4. Dissection of the **deltoid** and **scapular regions**: **acromio-clavicular joint** (5).

5. Superficial dissection of **arm** and **forearm** (2).

6. Deep dissection of the **front** of the **arm**: **antecubital fossa** (3).

7. Deep dissection of the **back** of the **arm**: **shoulder joint** (3).

8. Dissection of the **front** of the **forearm**, superficial dissection of the **palm** of the **hand** (5).

9. Deep dissection of the **palm** of the **hand** (4).

10. Dissection of the **back** of the **forearm** and the **dorsum** of the **hand** (5).

11. Dissection of the **elbow joint**, **wrist joint**, **joints** of the **hand** (3).

[1] Saturdays and Sundays are excepted.

THE REGION OF THE BACK

In the dissection of this region the dissectors of the arm are concerned only with the first two layers of the muscles of the back —that is, with those muscles connecting the upper limb with the vertebral column.

Surface Anatomy.—Along the centre line of the back the **spinous processes** of the **thoracic** and **lumbar vertebræ**—the only palpable parts of the vertebræ—are easily felt. As a rule they do not all lie exactly in the medial line, but some are deflected to one side or other. The spines are counted from the first **thoracic**, which makes, usually, a more marked projection than the seventh **cervical** (**vertebra prominens**). The **vertebral border** of the **scapula** can be defined usually with ease, its other borders less successfully. With the arm by the side the **upper angle** of the scapula lies opposite the second **intercostal space**, its **inferior angle** at the level of the seventh or eighth **rib**. The prominence of the **acromion** can be felt posteriorly, and the subcutaneous surface of the **spine** of the **scapula**, continuous with the surface of the acromion, should be traced as far medially as its root on the vertebral border. Distal to the scapula the lower five **ribs** can be felt, and it is important to observe the shortness of the interval which exists between the last rib and the **crest** of the **ilium**. The highest point of the iliac crest should be determined by measurement to be on the level of the fourth lumbar spinous process.

An incision is to be made in the middle line from the seventh cervical spinous process to that of the fifth lumbar vertebra; and others at right angles to it, from the upper end to the acromion process, and from the lower end along the iliac crest. The area of skin thus marked out is to be raised from the superficial fascia, and in this the **cutaneous nerves** of the back are to be sought. (The senior student will find it quite possible to make a clean dissection of the muscles at once, and at the same time to preserve all the cutaneous nerves.)

The **cutaneous** (sensory) **nerves** of the back (Figs. 1 and 2) are derived from the **posterior divisions** of the **thoracic spinal nerves** and are mostly of small size. They run more or less transversely across the back, but the lower members of the series have a distinct downward course. The upper six nerves are the terminations of the **medial** branches of the posterior divisions and pierce the trapezius muscle close to (about one inch from) the vertebral column. The lower six nerves are derived from the **lateral** branches of the posterior divisions and appear near the angles of the ribs, piercing the latissimus dorsi muscle more or less along the oblique line at which its muscular fibres commence. Small cutaneous

arteries accompany these nerves, serving as guides to their localisation; they are branches of the **intercostal** and **lumbar** arteries. The student should recognise that the cutaneous nerves of the back descend some distance from their origin before becoming superficial, so that the area of skin supplied by any one, is below the level of the spine by which it is numbered. The branches of the eighth thoracic nerve, for instance, are distributed opposite the twelfth thoracic and first lumbar spines.

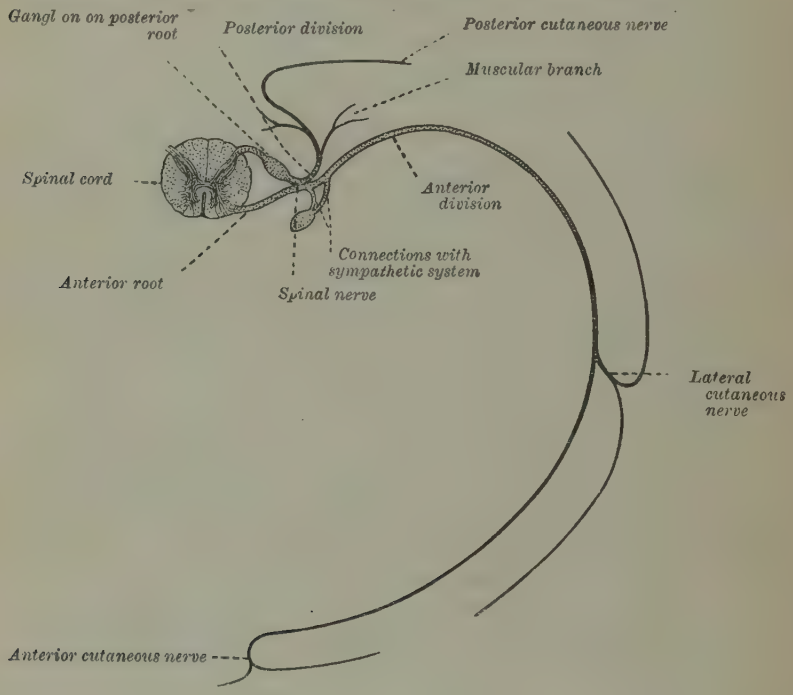

FIG. 1.

Diagram of the formation and distribution of a typical (upper thoracic) *spinal nerve.* A spinal nerve is formed by the junction of its anterior and posterior roots. It has but a short course, and divides into anterior and posterior divisions

It is best to secure the cutaneous nerves at the points where they first enter the superficial fascia, cutting through this fascia in the direction in which the nerves run till the deep fascia is reached. With a little experience the nerves are easily recognised and traced through the superficial fascia from their emergence from the muscles. Having secured and studied these nerves remove the superficial fascia and proceed to clean the **trapezius** and **latissimus dorsi** muscles. On the left side of the subject the dissector should

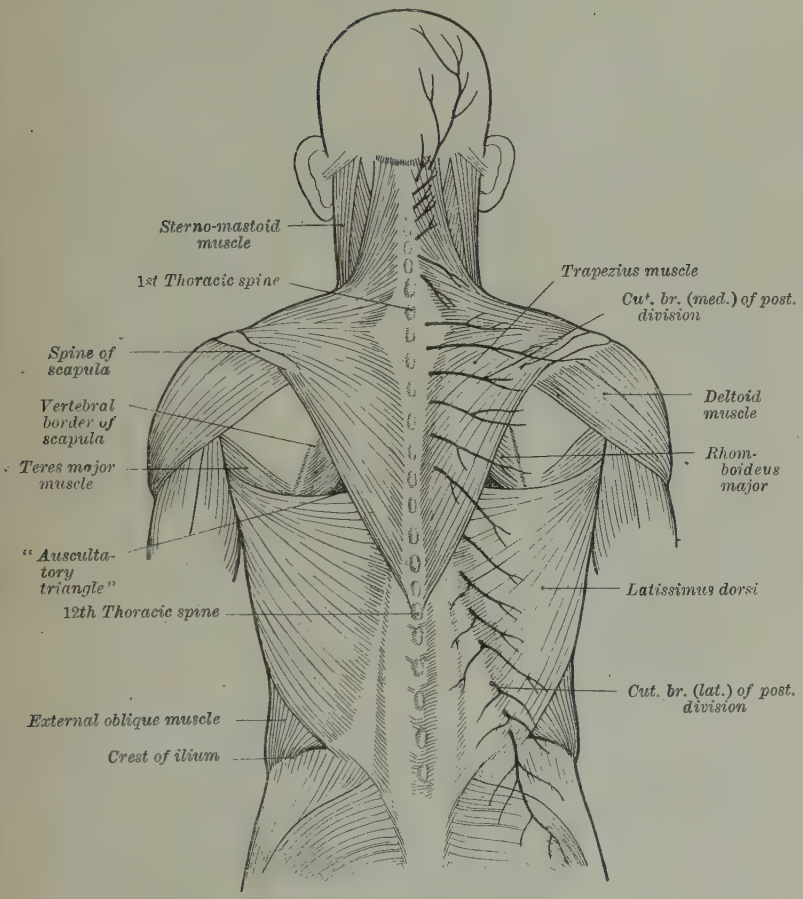

FIG. 2.

The superficial muscles and the cutaneous nerves of the back.

begin to clean the lower part of the latissimus dorsi and work upwards to the trapezius, but on the right side the dissector must begin towards the upper part of the trapezius and work downwards to the latissimus dorsi. (The cervical part of the trapezius and its upper border will be defined by the dissectors of the head and neck.) The arm, carrying with it the scapula, will require to be moved from time to time to stretch in turn the different sets of fibres. It is very important that the borders of the latissimus dorsi should be accurately defined.

The first layer of the muscles of the back (Fig. 2) consists of the **trapezius** and the **latissimus dorsi** muscles, and extends, along the vertebral column, from the occipital bone to the sacrum. The lower part of the trapezius overlaps the upper part of the latissimus dorsi, but between them and the vertebral border of the scapula there is a triangular interval, varying in size according to the position of the scapula, and in which the **rhomboideus major** muscle can be seen; and below the lower border of that muscle a small portion of the thoracic wall (sixth intercostal space) is uncovered by muscles. This area is termed the "auscultatory triangle." The lower border of the latissimus dorsi, between the last rib and the iliac crest, will usually be observed to overlap the posterior border of the **external oblique** muscle of the abdominal wall; but sometimes there is a narrow interval between the two muscles, and limited below by the crest of the iliac bone, in which the **internal oblique** muscle is seen. This space (Fig. 3) is termed the "**triangle of Petit**" (trigonum lumbale).

The **trapezius** muscle (Fig. 2) of each side is triangular, its fibres converging towards a confined insertion from a long medial linear origin. It arises (in the region of the head and neck) from the external occipital protuberance and the medial third of the superior curved (nuchal) line of the occipital bone, from the ligamentum nuchæ and the seventh cervical spinous process; and (within the confines of the dissection of the arm) from the spinous processes of all the thoracic vertebræ and the supra-spinous ligaments between them. It is inserted into the lateral third of the posterior border of the clavicle (upper fibres), and into the medial edge of the acromion process (middle fibres), and the upper border of the spine of the scapula as far medially as the tubercle at its root. This tubercle receives the insertion of a tendon, which glides over the triangle at the medial end of the spine, but separated from it by a bursa, and into which the lower thoracic fibres of the muscle are continued. It should be noticed that a semi-oval tendinous aponeurosis is present in the origin of the muscle opposite the last cervical and upper three or four thoracic vertebræ. This represents a substitution of tendon for muscle at this point, an arrangement which probably has reference to the relatively small range of backward movement of the scapula in this locality.

The **ligamentum nuchæ** is a band of white fibrous tissue which extends from the spinous process of the seventh cervical vertebra to the external occipital protuberance and crest, and is connected by small slips with the spines of the intervening vertebræ. It lies between, and gives origin to, the muscles of each side of the neck, and it is to be considered as an upward continuation of the supraspinous ligaments of the thoracic region. In some of the quadruped animals it is of greater development and is composed of yellow elastic tissue, and then helps to sustain the weight of the head.

In conjunction, and only so, with the dissectors of the head and neck, the trapezius is to be divided by a vertical incision one inch from the spines of the vertebræ, care being taken not to cut the subjacent tendinous origins of the **rhomboid** muscles in the upper thoracic region. The section of the muscle should be commenced at the lower end, for there its whole thickness can be determined by passing the finger under its lower border. The muscle is to be thrown laterally, and the medial strip raised and its attachment defined. The **nerves** and **vessels** of the trapezius (Fig. 3) will be exposed by a dissection of its deep surface, and are to be preserved till their continuity from above is displayed by the dissectors of the head and neck. The trunks of the nerves, which have already been found by the dissectors of the head and neck, are derived from two sources; two or three **branches** from the **cervical plexus** (anterior divisions of the third and fourth cervical spinal nerves), and the terminal branches of the **accessory** nerve (the eleventh cranial nerve). On the deep surface of the muscle these nerves join with one another to form the "subtrapezial plexus" from which twigs pass into the substance of the muscle. Accompanying the accessory nerve there will be found the **superficial** branch of the **transverse cervical artery**.

While the above dissection is being carried out, the following structures should be sought for, in conjunction with the dissectors of the head and neck, but they should be disturbed as little as possible in the meantime, since they will be seen better in a later dissection:—the **posterior belly** of the **omo-hyoid** muscle, a slender slip of muscle, which should be traced to its origin on the cranial margin of the scapula, from, and in the neighbourhood of, the **suprascapular ligament**: the **suprascapular artery** (a. transversa scapulæ) and the **suprascapular nerve**, which cross respectively over and under the suprascapular ligament to enter the **supraspinous fossa** of the scapula.

The **latissimus dorsi** muscle (Figs. 2 and 3) takes origin from the lower six thoracic spines and the intervening supraspinous ligaments; by a thin aponeurosis, which is fused with the lumbo-dorsal fascia, from all the

lumbar and the upper-sacral spines, and from the posterior third of the outer lip of the iliac crest; by a few fleshy fibres from the iliac crest in front of the aponeurosis; and from the lateral surface of the lower three or four ribs by fleshy slips which interdigitate with the lower slips of origin of the external oblique muscle of the abdominal wall. The muscular fibres are collected together as they pass over the inferior angle of the scapula, to which they frequently have a slight attachment, and are continued forwards and upwards as a compact bundle which twists on itself as it winds round the lower margin of the **teres major** muscle. It is inserted by a tendon into the bottom of the **bicipital groove** of the **humerus**. The fibres of muscle are so twisted that those which were highest at their origin are lowest at their insertion, and vice versa. At its insertion, which will be studied later, the tendon is separated from that of the teres major by a bursa.

Reflection of the **Latissimus Dorsi**.—The latissimus dorsi is to be divided by a curved incision beginning on the upper border two inches from the middle line, and ending on the lower border just below the last rib. The medial tendinous origin is to be thrown inwards, care being taken to leave intact the thin underlying muscle, the **serratus posterior inferior** (Fig. 3). The attachment of the aponeurosis to the vertebral column and its fusion with the lumbo-dorsal fascia are to be verified. The lateral muscular part is to be separated from the underlying muscle, the **serratus magnus** (m. serratus anterior)—a process requiring care—and the slips of origin from the ribs and the lower angle of the scapula are to be defined and then cut through. Care should be taken to secure at once, on the deep surface of the muscle, its nerve of supply, the **long subscapular** nerve a branch of the brachial plexus, and this should be traced to its terminations in the muscle substance. The terminal branches of the **subscapular artery**, accompanied by veins, are to be secured close to the long subscapular nerve, and should be traced as far as the lower angle of the scapula.

The **second layer** of the **muscles** of the **back**, now to be dissected (Fig. 3), comprises the **levator scapulæ** and the **rhomboideus minor** and **major** muscles, in that order from above downwards. These muscles should now be cleaned, carefully separated by blunt dissection from one another, and their attachments defined.

The **levator scapulæ** (Fig. 3) arises, within the dissection of the neck, from the posterior tubercles of the transverse processes of the upper four cervical vertebræ. It is inserted into the vertebral border of the scapula opposite the supraspinous fossa.

The **rhomboideus minor** (Fig. 3) is a narrow strip of muscle, arising from the lower part of the ligamentum nuchæ and from the spines of the seventh cervical and first thoracic vertebræ and the supraspinous ligament between. It is inserted into the vertebral border of the scapula opposite the root of the spine. It may be practically impossible in some cases to separate the rhomboideus minor from the major muscle, but a

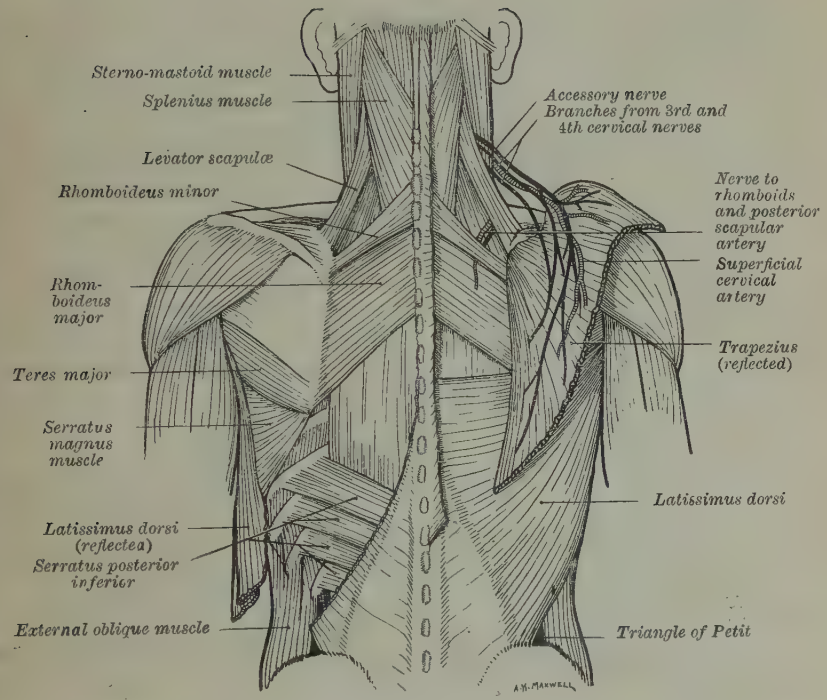

FIG. 3.

The second layer of the muscles of the back.

small artery which ascends between them is the guide to the required interval.

The **rhomboideus major** (Fig. 3) arises from the spinous processes of the upper four or five thoracic vertebræ below the first, and from the corresponding supraspinous ligaments. It is inserted into the vertebral border of the scapula opposite the infraspinous fossa, the middle fibres of the muscle being attached to a fibrous arch which is connected with the bone only by its extremities.

When these muscles have been cleaned and the attachments of each verified, the levator scapulæ should be divided—working in conjunction with the dissectors of the head and neck. Entering the deep surface of this muscle, care must be taken to define the nerves to it from the cervical plexus (cervical spinal nerves third and fourth); and passing downwards under cover of the muscle, near its insertion, the **nerve to the rhomboids** (n. dorsalis scapulæ) from the fifth cervical nerve, and the **posterior scapular artery**, a branch of the **transverse cervical** artery, must be secured and traced to the upper border of the rhomboideus minor. The rhomboidei should now be divided close to their origin and turned laterally. The dorsalis scapulæ nerve, and the accompanying artery, should then be traced along the whole length of their deep surface and their branches into the muscles defined.

At the anterior border of the levator scapulæ muscle the dissector should secure the trunk of the **transverse cervical artery** and its division into its two branches; the **superficial cervical** artery crossing that muscle to gain the under surface of the trapezius, and the **posterior scapular** branch passing under the levator scapulæ and the rhomboid muscles and along the vertebral border of the scapula as far as the inferior angle. The two branches are connected with one another at each border of the rhomboideus minor. It should be mentioned, however, that a variation in the arrangement of these vessels is frequently met with.

When the scapula is drawn away from the chest wall it will be observed that the space between the ribs and the serratus magnus (anterior) muscle is occupied by loose areolar tissue. When this is cleaned away a view of the deep or costal surface of the muscle is obtained as it sweeps round the chest to reach the vertebral border of the scapula.

The dissectors of the arm now stop work for two days, during which time the dissectors of the head and neck complete the dissection of the remaining muscles of the back. The body will then be turned, and the dissection of the arm is resumed in the **pectoral region** and the **axilla**.

THE PECTORAL REGION AND AXILLA

Surface Anatomy.—The **clavicle** is seen with ease; but the finger should be carried along the bone to determine its curvatures and to localise its articulations. The **acromio-clavicular** joint lies in a sagittal plane, and though, as is usually the case, the upper surfaces of the bones are on the same level, is easily detected during movements of the limb. At the **sterno-clavicular** joint, on the other hand, the clavicle may be felt to make a marked projection, and if the arm is freely moved, the extensive range of motion at this articulation will be appreciated. The **infraclavicular fossa** (**delto-pectoral** triangle) is the term applied to the interval which is usually present between the clavicular origins of the **pectoralis major** and **deltoid** muscles, and by pressing backwards and laterally in this space the **coracoid** process of the scapula will be felt. The roundness of the shoulder depends upon the projection of the humerus beyond the bony arch of the **acromion** above it, so that the point of the shoulder is formed by the humerus which is overlaid by the deltoid muscle. The anterior surface of the **sternum** can be felt throughout its whole length, and the prominent ridge at the junction of the **manubrium** and the **body**, the **sternal angle** (or the angle of **Ludwig**) should be carefully palpated; it indicates the level of the second costal cartilages. The ribs and costal cartilages below the first can easily be recognised, but the first can only be felt at its junction with the sternum. They are counted from the second. The development of the **mammary** region varies according to the sex and age of the subject. The advanced student should notice in the female subject the condition of the **nipple** and its surrounding **areola**, as indicative of previous pregnancies or the contrary. The position of the nipple varies considerably, even in the male. It lies most commonly over the fourth intercostal space—but in the female is often at a lower level—and is about $4\frac{1}{2}$ inches from the median line. By withdrawing the arm from the body, the anterior and posterior boundaries of the **axilla** (the armpit) will be made prominent. In this position of the arm the fascia extending across the axilla is tense, so that the finger cannot be pushed into the armpit; whereas, if the arm is brought to the side the fascia is relaxed and the head and neck of the humerus, with the great vessels of the arm on their medial side, can readily be felt. On the wall of the thorax possibly some lymphatic glands may be palpated.

The arm being drawn away from the side, an incision is to be made in the middle line the whole length of the sternum, and is to

be joined at right angles at its upper end by another running to the acromion process, and thence in a vertical direction half-way down the front of the arm. A third incision is to be made transversely from the lower end of the sternum, and must be carried to the posterior fold of the armpit (the latissimus dorsi muscle). The large flap of skin thus marked out is to be reflected towards the arm, the dissector of the right side beginning at the lower end of the sternum, and the dissector of the left side at its upper end. A circular incision of one inch radius is to be carried round the nipple in the female, so as to leave it attached to the mammary gland.

Beneath the skin is the **superficial fascia**, which is often very fatty. In a well-developed subject the fibres of the **platysma myoides** muscle (Fig. 4) may be seen arising from this fascia below the clavicle; and perforating the muscle the **supraclavicular** cutaneous nerves (Fig. 4) should be secured. The **mammary gland** is to be exposed in the female, and its extent and relations to the deep fascia beneath it are to be examined by making a transverse and a vertical incision through its substance. The skin left round the nipple is to be raised towards its summit, and beneath it the **lactiferous** ducts, each with its **ampulla**, will be seen; and these may be traced through the nipple to their opening on its summit. The **anterior cutaneous** nerves of this region are then to be isolated close to the sternum and traced laterally through the superficial fascia.

The **mammary gland** of the female is a gland of very variable bulk lying in the superficial fascia over the pectoralis major and serratus magnus muscles, from which it is separated by a quantity of loose cellular tissue. Its base is roughly circular, and reaches from the second to the sixth rib in a vertical direction, and transversely from the side of the sternum to beyond the margin of the pectoralis major into the axilla, where it rests on the serratus magnus muscle. From its pectoral surface small lobules may penetrate the cellular tissue (deep fascia), and by some observers have been said to become embedded in the fibres of the pectoral muscle. Immediately below the centre of its superficial surface, and usually between the fourth and fifth ribs, is the mammilla or nipple, around which is the areola of coloured skin, the tint of which becomes permanently darker in the first pregnancy. The nipple is pierced by numerous (fifteen to twenty) lactiferous ducts. Its skin is thin and delicate, and it contains a quantity of unstriped muscle, which is prolonged into the areola. The skin of the areola presents a number of little prominences due to the presence of small sebaceous glands (tubercles of Montgomery). The mammary gland consists of fifteen to twenty distinct lobes—radially arranged—surrounded and pervaded by the fibrous trabeculæ of the superficial fascia, which thus forms the stroma or framework of the gland. Many of these trabeculæ from the superficial surface of the gland are attached to the deep surface of the skin, and are termed the ligaments of Cooper. Fat is deposited in

the intervals between and around the lobes, giving the smooth contour to the whole organ. Each lobe has a separate lactiferous duct which runs towards the nipple, and beneath the areola is dilated into a lactiferous sinus or ampulla.

The **arteries** of the breast are derived from the lateral thoracic (external mammary) branch of the axillary artery, from the intercostal arteries, and from the perforating branches of the internal mammary artery. The **lymphatic vessels** of the mammary gland pass most directly and in greatest number to the pectoral group of the axillary lymph glands, but from the medial and lower parts the vessels are connected with the sternal and infraclavicular lymph glands and with the abdominal lymph vessels. A knowledge of these connections is of first importance to the surgeon when it is necessary to consider the removal of the breast for the eradication of cancerous disease.

Cutaneous Nerves of the Pectoral Region (Fig. 4).—The **anterior cutaneous** branches of the upper **intercostal** nerves pierce the pectoralis major muscle close to the side of the sternum, and are accompanied by the cutaneous perforating branches of the internal mammary artery. They appear at regular intervals in the intercostal spaces—except frequently in the first—and are of small size. The terminations of the descending cutaneous branches of the cervical plexus, the **supra-clavicular** nerves, will be found beneath or piercing the platysma muscle, and crossing the clavicle in three groups implied by their names, **sternal**, **clavicular**, and **acromial**. Some twigs reach as low as the fourth rib.

The superficial fascia and these cutaneous vessels and nerves being turned aside, the deep or pectoral fascia is exposed. This is rather a loose layer of cellular tissue. It is attached above to the clavicle, medially to the front of the sternum, is continuous below with the fascia covering the muscles of the abdominal wall, and laterally joins the fascia of the deltoid above, and at the lower border of the pectoralis major is continued into the axillary fascia. The **pectoralis major** is to be cleaned, its fibres being put on the stretch by drawing the arm from the side and supporting it at a convenient height on a board. Commence from below on the right and from above on the left side. The strong axillary fascia is to be left untouched. The fore part of the **deltoid** muscle is also to be cleaned, and in the interval between it and the pectoralis major the **cephalic vein** (Fig. 5) is to be found.

The **pectoralis major** muscle (Fig. 4) consists of sternal and clavicular portions, separated at their origins by a deep cellular tissue cleft. The sternal portion arises from nearly the whole length of the manubrium and body of the sternum, and also from the cartilages of the upper six ribs, and below from the aponeurosis of the external oblique muscle. The clavicular portion arises from the anterior surface of the medial half of the clavicle, and is separated from the deltoid muscle by a cellular tissue interval containing the cephalic vein, the humeral branch of the acromio-thoracic artery, and, just below the clavicle, one or two lymphatic glands. The muscle is inserted into the lateral lip of the bicipital groove

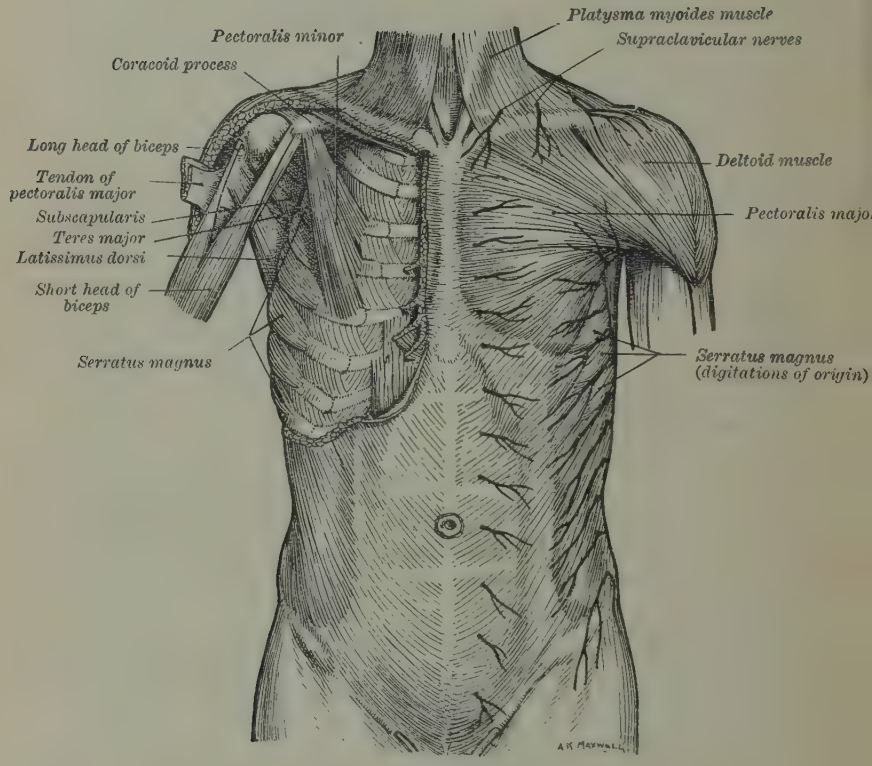

FIG. 4.

The pectoralis major and minor muscles and the cutaneous nerves of the chest. (On the right side the pectoralis major is removed, and the walls of the axilla are shown.)

of the humerus by two superposed laminæ, the superficial layer consisting of the clavicular fibres and the deep layer of the sternal fibres. The deep lamina is more tendinous than the superficial, and sends a prolongation upwards over the long head of the biceps to the capsule of the shoulder joint (Fig. 4), and from the lower border of the tendon a slip is given off to the deep fascia of the arm. The precise insertion of the muscle will be studied at a later stage.

[Muscular slips (forming the **sternalis** muscle) are not infrequently found lying superficial to the pectoral muscle at the side of the sternum; they are usually continuous with the sterno-mastoid or rectus abdominis muscles, or with both. A slip of some morphological and surgical interest, the **axillary arch** is often found near the axillary border of the pectoralis major, connecting it with the biceps or the latissimus dorsi muscles.]

If the skin has not been removed as far as the posterior boundary of the axilla (latissimus dorsi and teres major muscles), it should now be turned back. The deep fascia, the **axillary fascia**, will be seen stretching from the serratus magnus medially to the inner surface of the arm laterally, and forming the base of the conical space known as the armpit or **axilla**. Its centre part is cribriform, giving passage to lymphatic and small blood vessels, but its extremities are strong and well defined. The **lateral cutaneous** branches of the second and succeeding upper **intercostal vessels** and **nerves** (Figs. 4 and 5) are to be sought for below the lower border of the pectoralis major muscle, by carefully dividing the fascia covering the serratus magnus in a direction parallel to the ribs. The nerve to the serratus, the **long thoracic** nerve (Fig. 5), is to be secured at the same time. It lies on the surface of the muscle.

Lateral Cutaneous Vessels and Nerves (Figs. 4 and 5).—The first intercostal nerve, the anterior division of the first thoracic nerve, has no lateral branch, but from the second to the seventh nerves, six lateral branches will be found appearing on the side of the chest between the digitations of the serratus magnus. They are accompanied by corresponding arterial twigs from the intercostal arteries. Each lateral cutaneous nerve, except that of the second, divides into anterior and posterior branches, which run forwards to the pectoral region and backwards over the latissimus dorsi, respectively. The lateral cutaneous branch of the second nerve passes on to the medial side of the arm, and is hence called the **intercosto-brachial** nerve (Fig. 5), and the posterior branch from the third nerve usually accompanies and joins this. These nerves are to be found at once, and are to be most carefully preserved.

Before commencing the actual dissection of the axilla, it is desirable that the student should have some knowledge of its form, boundaries, and contents. The axilla is the pyramidal space between the chest wall and the upper part of the arm, the apex of the space being directed upwards and inwards towards the root of the neck. On transverse section, its four bounding walls (Fig. 4) are seen

to be formed of the following structures:—**In front** (Figs. 4 and 6), the pectoralis major muscle superficially, and deep to this the clavicle, the subclavius muscle, the costo-coracoid membrane, and the pectoralis minor, in that order from above downwards. **Behind,** the subscapularis, latissimus dorsi, and teres major muscles, from above downwards. On the **medial side,** the serratus magnus covering the upper four ribs and the intercostal spaces; and on the **lateral side,** the coracoid process, the upper part of the humerus, and the coraco-brachialis and the short head of the biceps muscle. The base of the pyramid has already been seen to be formed by the axillary fascia. The apex is truncated, and is represented by the triangular interval between the clavicle, the lateral part of the upper border of the scapula, and the first rib, and through this opening a free communication is allowed between the axilla and the root of the neck. The **axillary vessels** and the **brachial plexus of nerves**—the vessels and nerves of the arm—enter the axilla through its apex, resting on the medial wall, and having crossed from the inner to the outer side, descend along the lateral wall of the space. The axillary artery is at first on the medial side of the nerve cords, and the axillary vein keeps to the medial side of the artery.

By dissecting with the handle of the knife, the fat is to be removed piecemeal from the axilla, working upwards from the base, and the muscles which form its boundaries are to be cleaned so far as they can be exposed. Care must be taken not to injure any of the nervous or vascular contents, and in the first place the numerous lymphatic glands should be defined.

The **axillary lymphatic glands** are arranged in four groups. (1) An anterior or pectoral group, placed on the medial wall of the axilla along the lower border of the pectoralis major muscle. (2) A posterior or subscapular group, lying on the posterior wall of the axilla along the subscapular artery. (3) A lateral or brachial group on the outer wall, arranged along the axillary vessels. (4) The infraclavicular group is placed at the apex of the axilla and receives the efferent lymphatic vessels of all the lower groups.

The lymphatic glands, and any remaining fat, should now be removed, so that the contents of the lower part of the axilla (Fig. 5) may be defined individually. Working from below upwards on the serratus magnus muscle, secure and trace outwards on to the inner side of the arm the intercosto-brachial nerve, and define its connection with the **medial cutaneous** nerve of the arm. Should this connection not be established, proceed at once to clean the lower part of the **axillary vein,** along the medial side of which the nerve lies. Along the lateral side of the vein the **axillary artery**

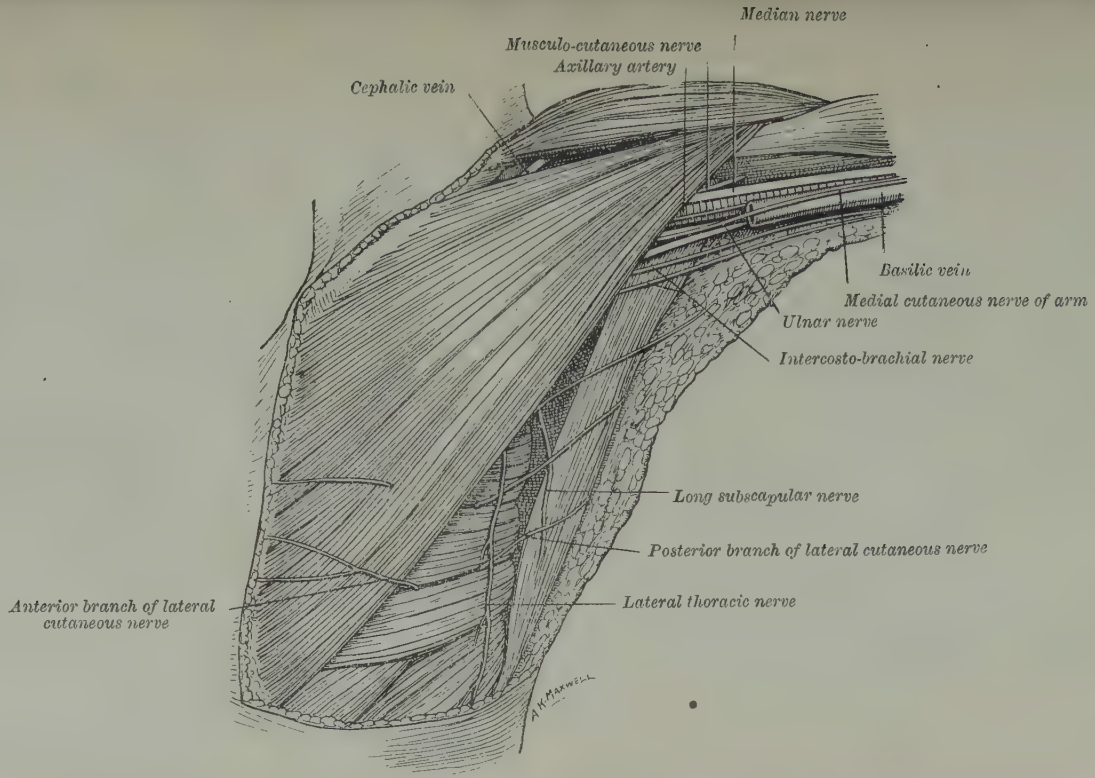

FIG. 5.—*Dissection of the lower part of the axilla.* (The lower part of the axillary vein has been removed.

will be found, and in the angle between the artery and vein the **medial cutaneous** nerve of the **forearm** should be isolated and traced upwards and downwards. In the same interval, but lying deep to that nerve, the much larger **ulnar** nerve should be obtained, and behind the artery the **musculo-spiral** nerve is to be secured. On the lateral side of the artery, between the artery and the coraco-brachialis muscle, the **median** nerve will be found, and at a somewhat higher level in the space the **musculo-cutaneous** nerve will be seen to enter the coraco-brachialis muscle.

It is important that the relations of the lower part of the axillary artery should be defined in this manner before any other dissection is made, as it is to this portion of the vessel—that is, the part beyond the lower border of the pectoralis major—that a ligature is most easily applied in surgical practice.

These structures having been isolated and recognised, the dissector should now proceed to remove the anterior wall of the axilla, so as to expose the axillary contents from the front, and also in order to be able to trace their continuity into the root of the neck. The clavicular portion of the pectoralis major is to be separated from its origin and turned laterally, but without injuring the cephalic vein. The branches of the **acromio-thoracic** artery, and of the **lateral anterior thoracic** nerve, which supply this part of the muscle, will be seen entering its deep surface. After clearing away some loose cellular tissue, which lies beneath the muscle—working carefully with the handle of the knife—the coracoid process and the insertion of the **pectoralis minor** will be exposed; and the **costo-coracoid membrane**, stretching from the upper border of that muscle to the under surface of the clavicle, should be defined, care being taken to preserve the vessels and nerve which pierce it.

The **costo-coracoid membrane** (or **clavi-pectoral fascia**) (Fig. 6) is a strong fascial layer which stretches between the clavicle and the pectoralis minor muscle and forms the upper part of the deeper layer of the anterior axillary wall. In its upper part it consists of two layers, which embrace the subclavius muscle and are attached to the two lips of the groove for the muscle on the under surface of the clavicle. Medially it is fixed to the first rib, and laterally to the coracoid process. The two layers unite below the subclavius, forming a thickened band, the costo-coracoid ligament, and the membrane then extends to the upper border of the pectoralis minor, where it splits into two to enclose that muscle. The membrane is pierced by the cephalic vein, on its way to join the axillary vein, the acromio-thoracic vessels, and the lateral anterior thoracic nerve. It will readily be understood that, as a part of the anterior wall of the axilla, the costo-coracoid membrane is placed in front of the upper part of the axillary vessels, the sheath of which, indeed, it helps to form.

The **subclavius** muscle (Fig. 7) (which is to be exposed by making an incision in the anterior layer of the costo-coracoid membrane, the two layers of which can thus be demonstrated) is a small muscle which arises from the first rib at its costo-chondral junction. It is inserted into a groove on the under surface of the middle third of the clavicle. Its nerve

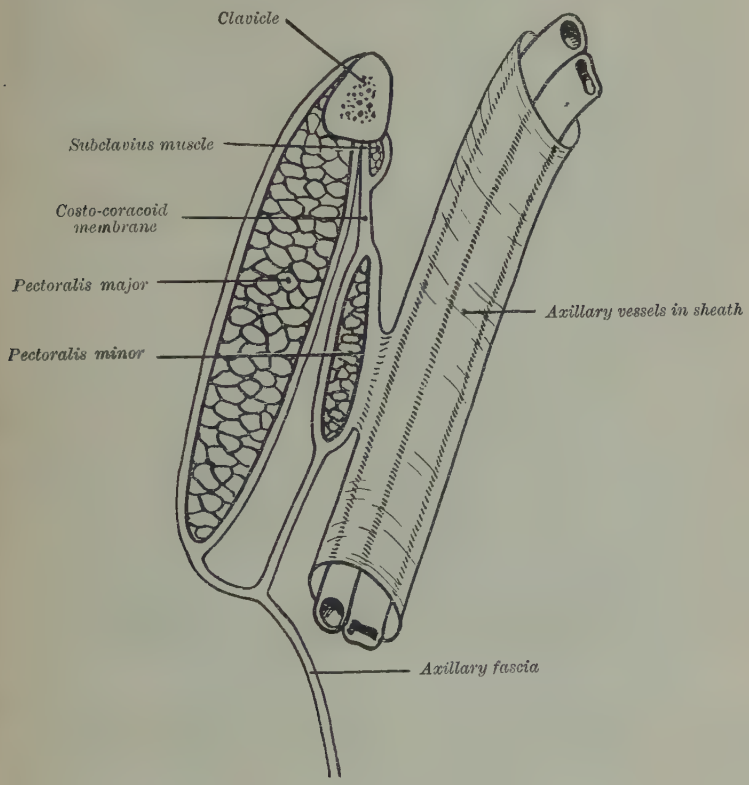

FIG. 6.

Diagram of the anterior wall of the axilla (in vertical section) *and its relation to the axillary vessels.*

supply is through a special branch of the brachial plexus derived from the trunk formed by the junction of the fifth and sixth cervical nerves, and has already been secured by the dissectors of the head and neck.

The sterno-costal part of the pectoralis major is now to be reflected from its origin and turned laterally, so as to expose the whole extent of the **pectoralis minor** muscle; and in doing so the branches of the **medial anterior thoracic** nerve, which issue through

the minor to enter the major muscle, will require to be divided. The costo-coracoid membrane is then to be carefully removed without injury to the structures which perforate it.

The **pectoralis minor** (Figs. 4 and 7) lies beneath the pectoralis major, and is invested on both surfaces by a fascia which is continuous above with the costo-coracoid membrane, and below with a fascial layer which extends in front of the axillary vessels and nerves to fuse with the axillary fascia. The muscle arises from the third, fourth, and fifth ribs (sometimes also from the second), and is inserted into the medial side of the coracoid process of the scapula near its extremity. It crosses over the axillary vessels and nerves obliquely and is used in the description of the artery, to divide that vessel into its three stages. It is supplied by the medial anterior thoracic nerve, which entering its deep surface afterwards perforates the muscle to reach the sterno-costal part of the pectoralis major.

The first parts of the axillary vessels, which lie above the upper border of the pectoralis minor muscle—and deep to the costo-coracoid membrane—have now to be exposed by removal of the surrounding sheath. This sheath is derived and carried downwards from the deep fascia of the neck, and is strengthened in the axilla by a process from the costo-coracoid membrane. In relation to the vessels in this situation the **lateral** and **medial anterior thoracic** nerves are to be secured, the former crossing the artery and the latter emerging between the artery and vein, while the **cephalic vein** is to be traced across the artery to its termination in the vein. The pectoralis minor muscle should then be divided about two inches from its origin and turned laterally, and the medial anterior thoracic nerve should again be secured as it enters the under surface of the muscle. The whole course of the axillary vessels and nerves will now be exposed (Fig. 7), and their continuity into the root of the neck is to be fully displayed by the removal, in conjunction with the dissectors of the head and neck, of the middle third of the clavicle and the subclavius muscle. (Should the dissection of the head and neck be sufficiently advanced, the clavicle should be disarticulated at the sternum.) The axillary artery and its branches have now to be followed out in detail, any superfluity of small veins being sacrificed to the better definition of those vessels ; and while the artery is being exposed the various branches of the brachial plexus are to be secured and defined. The **median** nerve, already defined on the lateral side of the lower part of the artery, is to be traced upwards, and its formation by the junction of its **medial** and **lateral heads** determined. These heads are to be traced in turn to the **medial** and **lateral cords** of the **brachial plexus** (Fig. 8), placed in the relationship indicated by their names to

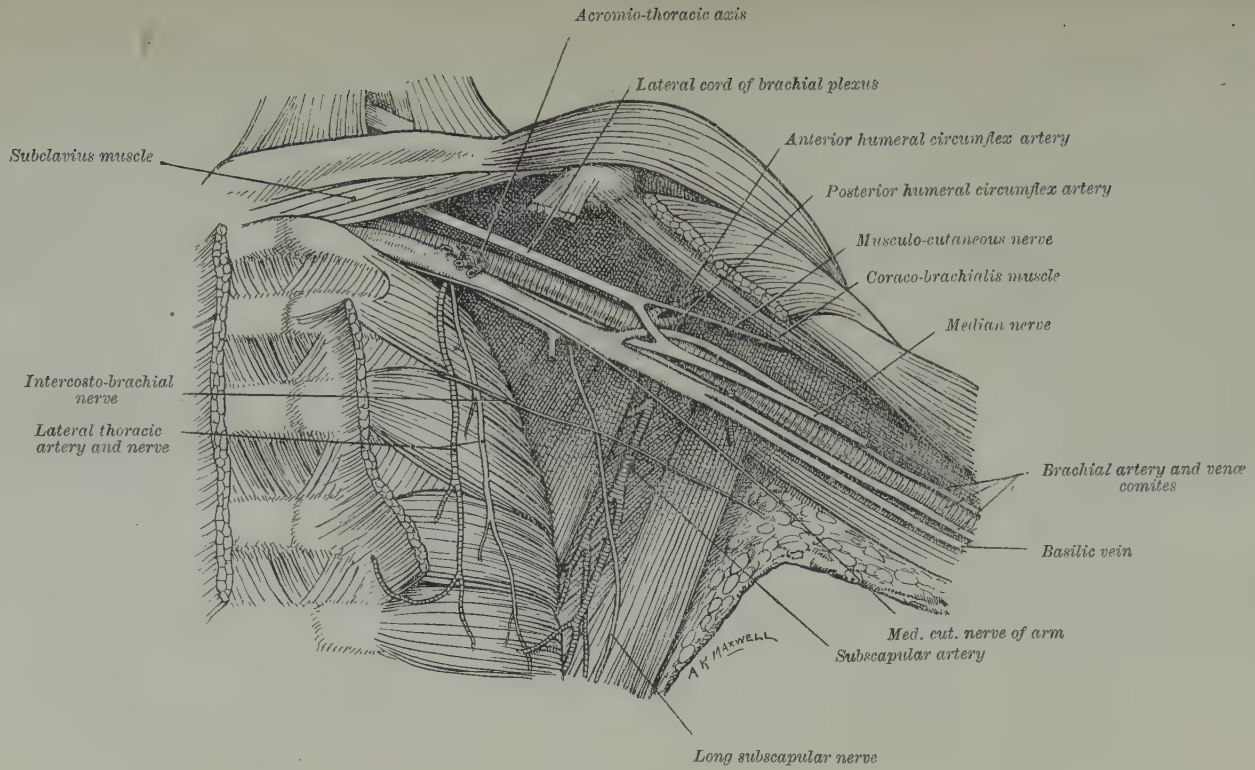

FIG. 7.—Dissection of the axillary space after removal of its anterior wall.

the part of the artery which lies deep to the pectoralis minor; while behind the artery in this position the **posterior cord** of the plexus, of which the **musculo-spiral** nerve is a derivative, is to be found. The **musculo-cutaneous** and the **lateral anterior thoracic** nerves are to be followed to their origin from the lateral cord, while the **ulnar** and the **medial cutaneous nerves** of the **arm** and **forearm** and the **medial anterior thoracic** are to be traced to the medial cord. The three great cords of the brachial plexus have now to be followed upwards into the root of the neck where they will be found to lie lateral to (above) the first part of the axillary artery.

The **axillary artery** (Figs. 7 and 8) is the continuation into the upper limb of the subclavian artery of the neck, and extends from the lateral border of the first rib to the lower border of the insertion of the teres major, where, passing into the arm proper, it is named the brachial artery. In its upper part it is placed deeply, and lies on the medial wall of the axilla, but having crossed the space from the inner to outer side, its lower portion is seen to lie on the lateral wall, and to be comparatively superficial. The artery is divided for purposes of description into three parts: the first, **above**; the second, **behind**; and the third, **below** the pectoralis minor.

In **front** of the axillary artery lie the structures which form the anterior wall of the axilla. The first part of the vessel, of small extent (from the lateral border of the first rib to the upper border of pectoralis minor), has in front of it the clavicular part of the pectoralis major muscle and the costo-coracoid membrane, and it is crossed by the cephalic vein and the lateral anterior thoracic nerve. The second part lies behind the pectoralis major and minor muscles, its extent being defined by the latter muscle. The third part of the artery (from the lower border of the pectoralis minor to the lower border of the teres major) has in front of its upper part the pectoralis major, but below the lower margin of this muscle, and while still within the axilla as determined by its relation to the muscles of the posterior wall, it is covered only by skin and fasciæ, and is therefore comparatively superficial. It is evident that this relationship is determined solely by the fact that the posterior wall of the axilla is of greater extent than the anterior wall, and, as already indicated, it is of importance should it be necessary to ligature the vessel. At its commencement the artery rests **behind** on the first and second digitations of the serratus magnus muscle, which cover the first intercostal space and the second rib; and lying here behind the artery and on the surface of the muscle, the long thoracic nerve is to be exposed and traced downwards. In its course across the axilla from the medial to the lateral wall, the vessel is at first separated from the posterior axillary wall by a cellular tissue interval containing the medial and posterior cords of the brachial plexus, which separate the artery from the subscapularis muscle. In its third part, however, the vessel is more directly in contact with the lower part of the subscapularis, and then rests successively on the tendon of the latissimus dorsi and a small part of the teres major muscle, the musculo-spiral and circumflex nerves intervening. Along the medial side of the artery throughout its length lies the axillary vein, in relation to which are disposed the brachial group of lymphatic glands. While to the lateral side there are the coracoid process and the muscles

arising from it, more particularly the coraco-brachialis. Disposed round the artery in remarkably constant relationship are, as already described, the several parts and branches of the brachial plexus.

The **branches** of the axillary artery (Fig. 7), which are now to be dissected out, are distributed on the axillary walls. In a general way, the upper branches pass on to the medial and anterior walls, while the lower branches ramify on the lateral and posterior walls. They are described as follows, but it should be mentioned that they are subject to a certain amount of irregularity in origin and distribution.

The **superior thoracic** artery (a. thoracalis suprema) is a small branch of the first part, arising at the lower border of the subclavius muscle and ramifying on the side of the chest, where it anastomoses with the internal mammary and intercostal arteries. The branches of the second part of the artery are the **acromio-thoracic** (a. thoraco-acromialis), the **lateral thoracic**, and the **alar thoracic** arteries. The **acromio-thoracic** (or thoracic) **axis** is a short branch which arises under cover of the upper margin of the pectoralis minor, and after winding round the upper border of that muscle pierces the costo-coracoid membrane and divides into four named branches. One (pectoral) runs forwards to supply the serratus magnus, intercostals, and both pectoral muscles; a second (acromial) passes outwards across the pectoralis minor and coracoid towards the acromion process and shoulder, and anastomoses with the posterior humeral circumflex and suprascapular arteries; a third (humeral) runs downwards in the interval between the pectoralis major and deltoid with the cephalic vein; and a fourth (clavicular) runs upwards towards the clavicle and subclavius muscle. The **lateral thoracic** artery runs along the lower border of the pectoralis minor on the side of the chest, supplying branches (sometimes called the external mammary) to the mammary gland. It anastomoses with the internal mammary, intercostal, and subscapular arteries. A separate external mammary artery often exists in the female, running parallel with but lateral to the lateral thoracic, and assists in supplying the breast. The **alar thoracic** vessels are twigs of supply to the axillary glands, seldom arising directly from the axillary, but generally from its branches. The branches of the third part of the axillary artery are the **anterior** and **posterior humeral circumflex** arteries, only the beginnings of which can be seen at present, and the **subscapular**. All of them usually arise close together near the lower border of the subscapularis muscle. The **subscapular** is a large branch which runs along the lower border of the subscapularis muscle to the side of the chest (with the long subscapular nerve) and ramifies on the serratus magnus and the latissimus dorsi muscles. Its terminal branches reach as far as the lower angle of the scapula where, as is specially mentioned later, they anastomose with the other scapular arteries. An inch or so from its origin this artery gives off a large branch, the dorsalis scapulæ (a. circumflexa scapulæ), which winds round the axillary border of the scapula, and after giving a ventral branch called the infrascapular, passes on to the dorsum of the scapula between the teres major and subscapularis muscles. The **anterior humeral circumflex** is a small branch which winds round the front of the surgical neck of the humerus beneath the coraco-brachialis and biceps, which it supplies. The **posterior humeral circumflex**

is larger than the anterior, and winds behind the surgical neck of the humerus (with the circumflex nerve). It reaches the deep surface of the deltoid muscle. The further course of these vessels will be studied in a later dissection.

The **axillary vein** (Fig. 7) lies in its whole length along the medial side of the axillary artery, and is in intimate relationship with the brachial group of lymphatic glands. It is formed by the junction of the basilic vein with the venæ comites of the brachial artery, usually near the upper border of the teres major, and having received tributaries corresponding more or

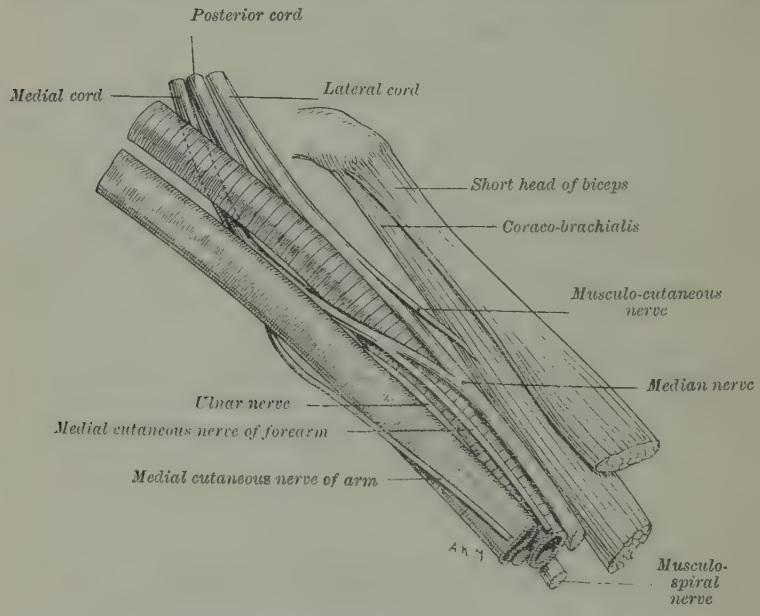

FIG. 8.

Diagram to show the relations of the axillary vessels and the brachial plexus.

less to the branches of the axillary artery, and the cephalic vein immediately below the clavicle, it reaches the lower border of the first rib and becomes the subclavian vein.

The axillary vein should now be divided close to the first rib between two ligatures, its branches cut through, and the whole vein thrown laterally. In conjunction with the dissectors of the head and neck, the **brachial plexus** and its branches should now be cleaned and studied.

The **brachial plexus** (Figs. 8 and 9) is formed from the anterior divisions of the fifth, sixth, seventh, and eighth cervical and the first thoracic nerves.

(There is usually in addition a communicating branch from the fourth cervical, and occasionally one from the second thoracic nerve.) These **nerves** make their appearance in the posterior triangle of the neck, and when traced laterally join with one another and divide again in a remarkably constant manner. The fifth and sixth nerves unite to form an upper trunk ; the seventh continues distally as a middle trunk ; while the eighth cervical and first thoracic nerves join to form a lower trunk. Each of the three **trunks** then splits into an anterior and a posterior

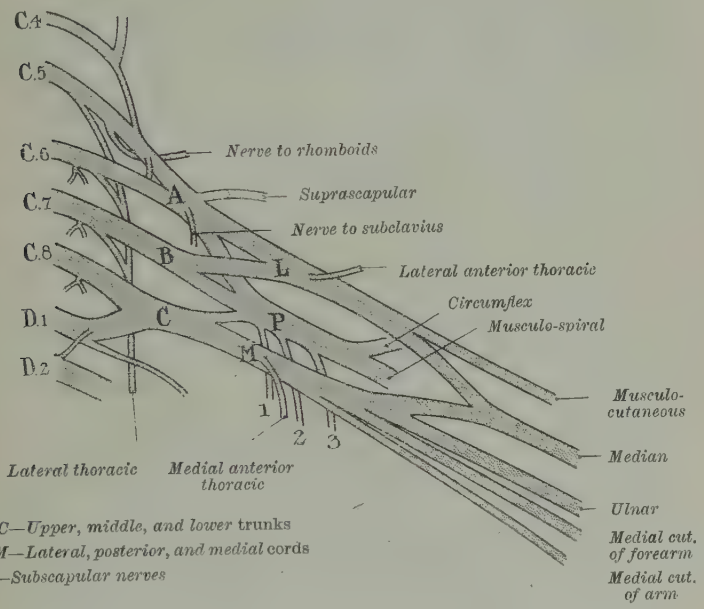

FIG. 9.

Diagram of the formation and distribution of the brachial plexus.

division, and these reunite to form the three **cords** of the plexus, which enter the axilla lying to the lateral side of the first part of the axillary artery. The three posterior divisions unite to form the posterior cord, and of the anterior divisions, the upper two join to constitute the lateral cord, while the lowest anterior division continues distally by itself as the medial cord. The posterior and medial cords pass behind the second part of the axillary artery, and the latter continues its course to reach the medial side of the vessel, but the lateral cord remains on the lateral side of the artery ; and the several branches derived from these cords, and now to be examined, more or less surround the artery in its third part.

The branches of the plexus are classified according as they arise from its nerve roots, its trunks, or its cords, but it should be pointed out that, clinically, it is often of importance to know

definitively from which spinal nerves the several branches of the trunks and cords arise. It should be noted, therefore, that the lateral cord is formed from the fifth, sixth, and seventh cervical nerves, and the medial cord from the eighth cervical and first thoracic, and that while the posterior cord is connected with all the nerves entering the plexus, it is derived mainly from the uppermost of the series. The posterior divisions of the trunks, therefore, will be found to diminish markedly in size from above downwards.

The branches of the **cords**, with which the dissectors of the arm have to do, are as follows:—

Lateral cord . . .	Lateral anterior thoracic.
	Musculo-cutaneous.
	Lateral head of median.
Medial cord . . .	Medial anterior thoracic.
	Medial cutaneous of arm.
	Medial cutaneous of the forearm.
	Medial head of median.
	Ulnar.
Posterior cord . .	Three subscapular nerves: upper, middle, and lower.
	Circumflex.
	Musculo-spiral.

These branches are to be identified, their origins established, and their relations to the axillary artery, as already described, are to be confirmed; but the description of them is more conveniently taken at a later stage of the dissection. In addition to them, however, the nerve which supplies the rhomboid muscles (n. dorsalis scapulæ), and the **long thoracic** nerve which supplies the serratus magnus, are to be studied by the dissectors of the arm. They should be traced upwards behind the axillary vessels and through the scalenus medius muscle of the neck to their origins from the **roots** of the plexus. The **nerve to the subclavius** and the **suprascapular** nerve should also be followed to their origins from the upper **trunk**. The nerves which supply the pectoral muscles are fully displayed, and their whole course should be followed out.

The **lateral anterior thoracic** nerve is a branch of the lateral cord. It crosses the first part of the axillary artery and pierces the costo-coracoid membrane, and enters the under surface of both parts of the pectoralis major, which it supplies.

The **medial anterior thoracic** nerve is a smaller branch and arises from the medial cord. It emerges between the axillary artery and vein, and after communicating with the preceding nerve across the front of the

artery, enters the deep surface of the pectoralis minor which it supplies. It sends, further, a terminal twig through that muscle to the lower part of the pectoralis major.

The dissector should recognise that he has now completed the dissection of the contents of the axilla, and that he has studied, during its removal, the whole of its anterior wall—that is, of those structures which are placed in front of the axillary vessels and nerves. He should now examine the other axillary walls, though at the present stage only the medial can be fully exposed. The brachial nerve cords should be tied together and divided with the axillary artery (between ligatures) opposite the first rib, and both structures are to be turned laterally. The serratus magnus muscle can now be cleaned, its surface being fully exposed by drawing the extremity well away from the body, and care must be taken to dissect out on its surface the nerve of supply, the **long thoracic nerve.**

The **serratus magnus** (m. serratus anterior) (Fig. 7) lies in contact with the chest wall. It arises by eight digitations from the anterior ends of the upper eight ribs. The first digitation is attached to the first and second ribs and to a fibrous arch bridging the first intercostal space, but the other slips are attached to one rib only. The lower three slips interdigitate with the external oblique muscle of the abdominal wall. The fibres of the muscle have a general direction backwards, and are inserted on the ventral surface of the scapula on a linear area bordering the vertebral margin of the bone. The first two digitations unite to form a thick bundle which is attached at the upper angle, while the last three or four form a still larger bundle which is attached to the area adjoining the inferior angle ; but the intermediate portion forms a thin muscular sheet which has only a slender attachment to the vertebral border between the upper and lower attachments. The muscle is supplied by the **long thoracic nerve**, which arises in the root of the neck from the brachial plexus by three branches. The upper two roots (one from the fifth and one from the sixth cervical nerve) pierce the scalenus medius muscle a little lower than the nerve to the rhomboids, and uniting into one trunk supply the upper part of the serratus. The third root arises from the seventh cervical nerve, passes in front of the scalenus medius and runs downwards for some distance before uniting with the other part of the nerve, which then gives off branches to each of the lower digitations of the muscle. (The unusual occurrence of the nerve entering the superficial surface of the muscle should be noted. The nerve supply of the serratus magnus is an apparent exception to the fact that practically all skeletal muscles are innervated from their deep surface.)

The serratus magnus should now be divided about one inch from its insertion, and after cutting the dorsalis scapulæ and the suprascapular nerves, the transverse cervical and suprascapular arteries and the posterior belly of the omo-hyoid muscle, the limb should be removed from the trunk, and taken to a separate table for further dissection.

DELTOID AND SCAPULAR REGIONS

Before commencing any further dissection, it is advisable to examine again the insertions of the several muscles on the scapula and clavicle, cutting each muscle about one inch from its insertion, and carefully defining the precise extent of its attachment. The insertion of the **trapezius** extends along the upper border of the spine of the scapula, the medial border of its acromion process, and along the posterior border of the lateral third of the clavicle. The **omo-hyoid** arises from the upper margin of the scapula close to the suprascapular notch, and from the suprascapular ligament. The **levator scapulæ** is inserted into that part of the vertebral border of the scapula which is above the basal triangle at the root of the spine; the **rhomboideus minor** into the part opposite the basal triangle; and the **rhomboideus major** into the rest of the border by means of a tendinous arch to which the muscle fibres are attached. The **serratus magnus** is inserted on to an area on the ventral surface of the scapula close to the whole length of the vertebral border, but with much thicker bundles at the upper and lower angles than in the middle. The **pectoralis minor** is inserted into the medial border and upper surface of the coracoid process, the tip of which gives origin to the **coraco-brachialis** and the short head of the **biceps** muscles.

A block is now to be placed under the axillary border of the scapula, and the skin is to be removed from the upper and lateral parts of the shoulder, and as far down the arm as the insertion of the **deltoid** muscle. In the superficial fascia the cutaneous nerves of this area should be sought, care being required to secure the branches of the **circumflex** nerve, which turn round the posterior border of the deltoid. The deltoid muscle is then to be cleaned.

The **cutaneous nerves** of the shoulder (Figs. 11 and 12) are derived from two sources: –(1) The **acromial** group of the descending cutaneous branches of the cervical plexus, the cut ends of which should be secured and the nerves traced to the proximal parts of the region. (2) The cutaneous branches of the **circumflex** nerve, itself an offshoot of the posterior cord of the brachial plexus. The cutaneous branches consist of several fine twigs which perforate the deltoid muscle, and a large branch, the lateral cutaneous nerve of the arm, which winds round the posterior border of the muscle. These nerves supply the distal parts of the region.

The **deltoid** muscle, the muscle of the shoulder, arises from the anterior border of the lateral third of the clavicle, from the lateral edge of the acromion and from the lower lip of the spine of the scapula. Its fibres pass outwards over the shoulder joint and converge to be inserted into a rough V-shaped surface, the deltoid tuberosity, on the lateral surface of the shaft of the humerus just above the middle. This area is embraced

by the bifid origin of the brachialis muscle. The deltoid muscle is coarsely fasciculated and is often separable into three parts, a central and an anterior clavicular and a posterior spinous part. Its centre portion is intersected by tendinous septa, four of which are attached above to tubercles on the lateral border of the acromion process, and three, alternately placed to those above, are attached below to vertical ridges on the deltoid impression of the humerus. These intersections are to be seen on transverse section, and a portion of the muscle is to be teased apart to demonstrate the oblique course of the fibres between the septa.

Two intermuscular intervals (Fig. 10) require to be referred to in the present dissection, but the student should understand that it is only by an artificial separation of the parts that they are made apparent as spaces. They are to be dissected from the front. The "**quadrilateral space**" is the interval bounded by the teres major below, the teres minor above, the humerus laterally, and the long head of the triceps medially; and passing through the space, the posterior humeral circumflex vessels and the circumflex nerve should be secured. The "**triangular space**" is bounded by the teres major below, the teres minor above, and the long head of the triceps laterally; the dorsalis scapulæ branch of the subscapular artery will be seen entering the space to reach the infraspinous fossa. These structures and their relations having been defined, the deltoid is to be divided near its origin and turned down, the circumflex vessels and nerve, which will now be seen on its deep surface, being preserved. In reflecting the muscle, a large bursa lying between the deltoid and the shoulder joint, and extending under the acromion process, should be noticed. The remains of the trapezius muscle are now to be cut close to the spine of the scapula.

Parts under Cover of the Deltoid (Fig. 10).—The deltoid muscle is wrapped round the shoulder joint, enveloping it from above and in front and behind. Anteriorly the muscle covers the coracoid process and the muscles attached to it, and posteriorly it overlies the muscles which arise from the dorsum scapulæ and from the axillary border of the bone, and which pass to be inserted on the upper extremity of the humerus. Under its central part are the coraco-acromial ligament, the subacromial bursa, and the head and neck of the humerus. More intimately related to its deep surface, and from there entering its substance, are the circumflex vessels and nerves. The examination of these structures is the next part of the dissection.

The **sub-acromial bursa** occupies the interval between the upper surface of the shoulder joint, covered by its muscles, and the under surface of the deltoid, acromion process, and coraco-acromial ligament.

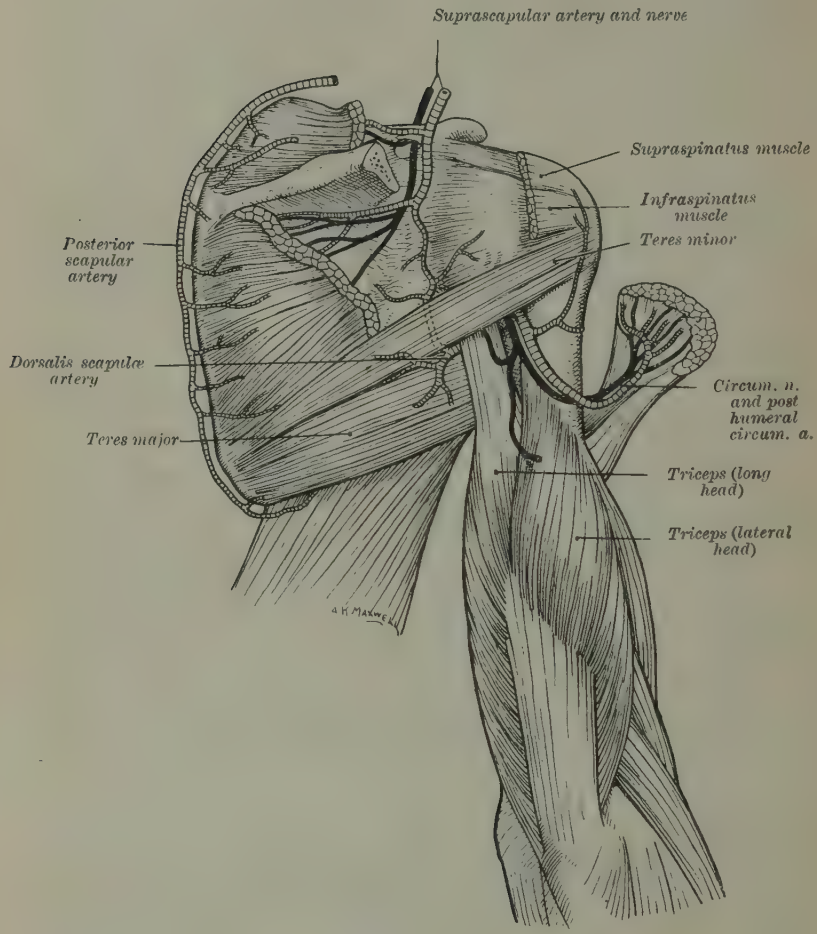

FIG. 10.

Di section of the scapular region from behind.

It is an extensive sac, and should be explored by the finger after an incision has been made in it. It is liable to inflammatory disturbances which may simulate disease of the shoulder joint.

The **circumflex nerve** (Fig. 10) is a branch of the posterior cord of the brachial plexus, and leaves the axilla by passing round the lower border of the subscapularis muscle and then backwards through the quadrilateral space. On the posterior aspect of the limb, and under cover of the deltoid, it divides into anterior and posterior branches. The latter gives off a branch to the teres minor (characterised by a gangliform swelling on it), a few twigs to the deltoid, and ends as the lateral cutaneous nerve of the arm ; while the anterior branch continues forward under the deltoid, the major portion of which it supplies, and sends twigs through the muscle to become cutaneous.

The **circumflex humeral arteries** (Figs. 7 and 10) have been seen to arise within the axilla from the third part of the axillary artery, but not infrequently they are branches of the subscapular or of the profunda branch of the brachial. The **posterior** vessel proceeds backwards through the quadrilateral space (with the circumflex nerve), and winding round the surgical neck of the humerus, breaks into numerous branches on the deep surface of the deltoid muscle. It anastomoses there with the anterior circumflex artery and with the acromial branch of the acromio-thoracic artery. The **anterior** circumflex artery passes round the front of the humerus at the same level, under cover of the coraco-brachialis and biceps muscle, and its anastomoses with the posterior vessel on the deep surface of the deltoid are easily established. It gives off an ascending branch which runs up to the shoulder joint in the bicipital groove.

The dissector should now examine the osteo-ligamentous arch over the shoulder joint. Commence by cutting off the trapezius and deltoid muscles close to their attachments to the clavicle, the acromion, and the spine of the scapula, and it will be noted that the shoulder joint is protected from above by the bony arch formed by these parts. In the removal of this arch, which must now be undertaken, the **acromio-clavicular articulation** is first to be localised and examined, and in connection with it the **coraco-clavicular ligaments** must be studied. After the separation of the clavicle at that joint, the **coraco-acromial ligament** can be defined, and its intimate relation to the shoulder joint, and its importance in the mechanism of that articulation, will be appreciated at once.

The **acromio-clavicular articulation** is a diarthrodial joint. The superior acromio-clavicular ligament is not easily defined, but is a quadrilateral band of short fibres (more or less connected with the fibres of the trapezius and deltoid), which covers the joint above. It is continuous in front and behind with the inferior acromio-clavicular ligament, which is placed below the joint, the two forming a complete but weak capsule for the articulation. The superior ligament should be divided close to the acromion and the joint cavity thus opened into. An inter-articular fibro-cartilage of triangular shape separates the bony surfaces from each other. The base of the cartilage is attached to the superior ligament ; it is usually imperfect below, but occasionally it

may be found complete and then divides the synovial cavity into two parts. The joint fissure runs almost straight from before backwards, but it should be noted that the articular surfaces of the bones are so inclined to one another as to favour upward displacement of the clavicle upon the acromion.

The **coraco-clavicular ligaments**, two in number, bind the inferior surface of the clavicle to the coracoid process, and should be viewed as accessory, though in function the main, ligaments of the acromio-clavicular joint. The names **conoid** and **trapezoid** have been given to the two ligaments, and they are separated from one another by the insertion of the subclavius and by a bursa. The conoid ligament is the posterior, and resembles a cone with the base upwards. It is attached to the posterior and medial part of the base of the coracoid process below, and to the conoid tubercle and the adjacent bone on the under surface of the clavicle above. The trapezoid ligament is a quadrilateral band of fibres attached to the line on the posterior part of the upper surface of the coracoid process below, and to the line on the under surface of the clavicle leading to the conoid tubercle above. It is anterior and lateral to the conoid ligament.

The **coraco-acromial ligament** (Fig. 16) is a fibrous tissue band of considerable strength, which is attached to the lateral side of the coracoid process by its broader end and by its smaller end to the tip of the acromion process. It is often cleft by the passage of small vessels. It arches above the shoulder joint but is stretched somewhat loosely between its attachments so that it may adapt itself to the curve of the head of the humerus, for which it forms (with the acromion and coracoid) a secondary socket in the upward movement of the bone. The sub-acromial bursa has already been noted to reach inwards on to its under surface.

The acromion process must now be divided with the saw at its junction with the spine of the scapula, and with the coraco-acromial ligament is to be turned forwards. A group of muscles (Fig. 10), arising from the scapula and passing laterally to be inserted on the upper end of the humerus, will now be displayed in their entire extent, and are to be cleaned by the removal of their strong fascial coverings. These muscles, to be recognised by their position, are the **supraspinatus** and **infraspinatus**, occupying, respectively, the supraspinous and infraspinous fossæ on the dorsum of the scapula; the **teres minor** arising from the axillary border of the bone, and closely conjoined with the lower border of the latter muscle; the **subscapularis** filling the subscapular fossa; and the **teres major**, lying lower than the teres minor, and closely related with the tendon of the latissimus dorsi.

The supraspinatus and infraspinatus have to be studied first and are then to be raised from their origins by blunt dissection and turned lateral-wards. The **suprascapular** artery and nerve (Fig. 10) are to be secured at the upper border of the scapula, where they were previously divided, and are then to be followed out in their whole course beneath the reflected muscles; and in the infraspinous

fossa the **dorsalis scapulæ** branch of the subscapular artery (Fig. 10) is to be secured and traced to its anastomoses with the suprascapular vessel. The teres minor muscle is then to be studied and the branch of the **circumflex** nerve which supplies it traced into its substance.

The **supraspinatus** muscle (Fig. 10) occupies the supraspinous fossa. It arises from the medial two-thirds of the fossa itself, from the upper surface of the spine, and from the thick fascia covering the muscle. The tendon passes beneath the acromion, from which it is separated by the subacromial bursa already noted, and is inserted into the uppermost facet on the great tuberosity of the humerus. It is closely adherent to the capsule of the shoulder joint, as will be determined when the muscle is reflected.

The **infraspinatus** muscle (Fig. 10) arises from the medial two-thirds of the infraspinous fossa (the part near the neck of the scapula being free from muscular attachments in all the scapular fossæ), and from the fascia covering the muscle. It is inserted into the middle facet on the great tuberosity of the humerus, and its tendon is closely adherent with the capsule of the shoulder joint, being blended there with the supraspinatus and teres minor.

The **suprascapular nerve** (Fig. 10) takes origin from the fifth and sixth cervical nerves, and runs transversely across the root of the neck to the upper border of the scapula. It then passes through the suprascapular notch, beneath the suprascapular ligament, and enters the supraspinous fossa, lying under the supraspinatus muscle to which it gives branches. It continues into the infraspinous fossa, running across the neck of the scapula, and round the free border of the spine, and there it ends in the infraspinatus muscle, which it enters from its deep surface.

The **suprascapular artery** (Fig. 10) arises in the root of the neck, and passes over the suprascapular ligament, and into the supraspinous fossa where it ramifies beneath the muscle. A branch, which winds with the nerve round the lateral border of the spine, reaches the infraspinous fossa, and there anastomoses with the dorsalis scapulæ and posterior scapular arteries under cover of the infraspinatus muscle. Before crossing the suprascapular ligament, the vessel sends a small subscapular branch to the ventral surface of the scapula to be distributed in the subscapular fossa.

The **subscapular artery** (Fig. 7) is still to be seen running along the axillary border of the scapula, and its branches should now be followed out on to both surfaces of the bone. The ventral branches, passing into the subscapular fossa, are derived from the main trunk, and from the dorsalis scapulæ. The dorsal branches, the largest being the dorsalis scapulæ (Fig. 10), pass mainly into the infraspinous fossa. As seen from the front, the dorsalis scapulæ passes through the "triangular space," but as seen from behind, it winds beneath the teres minor in a groove on the axillary border of the scapula, and enters the infraspinous fossa to anastomose with the posterior scapular and suprascapular arteries. It gives off a ventral or "infrascapular" branch, which may be traced beneath the subscapularis. The terminal branches of the subscapular artery reach down to the angle of the scapula where they anastomose with the posterior scapular artery.

The **teres minor** muscle (Fig. 10) is closely connected with the infra-

spinatus. It arises from an impression on the axillary border of the scapula opposite the upper part of the infraspinous fossa, and is inserted into the lowest facet on the great tuberosity of the humerus, and for nearly an inch below it. It is closely connected with the capsule of the shoulder joint as it crosses it. Towards its insertion it is separated from the teres major since it passes behind the long head of the triceps, and is thus excluded from the posterior wall of the axilla. It is supplied by a special branch of the circumflex nerve, which has an enlargement on it of perineural connective tissue—called a gangliform swelling.

The remaining scapulo-humeral muscles, the subscapularis and teres major, and the tendon of the latissimus dorsi, which is associated with them, form, as has already been described, the posterior wall of the axilla. These muscles should be cleaned and traced to their attachments, and the relation of the tendon of the latissimus dorsi to the teres major is to be specially studied. The nerves to these muscles, the **subscapular** branches of the posterior cord of the brachial plexus, can now be fully exposed, and are to be traced from their origin to their terminations. The subscapularis muscle is then to be dissected from its origin so as to display its tendinous septa and the bursa underneath its insertion.

The **subscapularis** muscle arises from the whole of the ventral surface of the scapula, except the part to which the serratus magnus is attached, and that close to the neck of the bone. The muscle has several tendinous septa intersecting its substance, and these are attached to the ridges on the surface of the bone. The muscle passes laterally across the neck of the scapula and under the coracoid process, and is inserted into the lesser tuberosity of the humerus and on the shaft below it for one inch. It is closely attached to the capsule of the shoulder joint. A large bursa intervenes between the muscle and the neck of the scapula, and almost always communicates with the cavity of the joint.

Insertion of the Latissimus Dorsi.—The latissimus dorsi muscle has been traced as far as the lower angle of the scapula. There it ends in a thin tendon which passes in front of the teres major after winding round its lower border, and is inserted into the floor of the bicipital groove of the humerus, a bursa intervening between it and the teres tendon. From the inferior margin of the tendon of the latissimus, a fibrous slip will be observed passing distally, to be attached to, usually, the long head of the triceps. This is a rudiment of the dorso-epitrochlearis muscle, which is more highly developed in the lower mammals.

The **teres major** muscle (Fig. 10) arises from an oval impression in the infraspinous fossa in the neighbourhood of the inferior angle of the scapula, and is inserted into the medial lip of the bicipital groove of the humerus in close relationship with the latissimus dorsi.

The **subscapular nerves** are branches of the posterior cord of the brachial plexus, and are three in number, all of which arise within the axilla. They have a general direction downwards behind the axillary vessels and the other axillary nerves to their distribution in the muscles of the posterior wall of the axilla. The short subscapulars, the upper and lower nerves, pass to the subscapularis and teres major, respectively,

and the long or middle subscapular is the nerve of supply to the latissimus dorsi.

Vascular Anastomoses round the Scapula (Fig. 10).—By removing the muscular fibres from both surfaces of the scapula, an anastomosing network of vessels will be seen, formed by branches of the three scapular arteries. On the dorsum scapulæ, the suprascapular artery anastomoses with the posterior scapular and with the dorsalis scapulæ branch of the subscapular; and on the ventral surface of the bone the ventral branches of these same vessels unite with one another. The importance of these communications depends on the fact that two of the main arteries concerned arise from the subclavian, while the third, the subscapular, springs from the axillary artery. If the subclavian or axillary vessels be ligatured between these branches, their anastomoses afford ample means of conserving the blood supply to the upper limb, forming what is termed a **collateral circulation** between the subclavian and axillary vessels.

SUPERFICIAL DISSECTION OF THE ARM AND FOREARM

It is advisable to make a superficial dissection of the whole of the arm and forearm together, as distinct from the subsequent deeper dissection of these parts of the limb in definite stages, so as to display in their continuity the cutaneous nerves and the superficial veins. To this end, after studying its surface form, an anterior medial vertical incision should be made down the limb as far as the wrist, and there joined by an anterior transverse incision. The skin should then be removed from the arm and forearm, front and back, but left attached at the wrist posteriorly to be used as a protective covering between the times of dissection.

Surface Anatomy.—The biceps muscle forms a prominence on the front of the arm, and on either side of it there is a faint groove. The **brachial artery** can be traced by palpation along the medial furrow as far as the bend of the elbow, and the shaft of the humerus can readily be felt deep to the vessel. The position of the insertion of the deltoid can be seen to be on the lateral groove. In front of the elbow there is a hollow known as the **antecubital fossa**, and here the superficial veins may be seen beneath the skin. The prominent medial epicondyle of the humerus can be seen and the rounder lateral epicondyle can be felt; their relations to the olecranon process of the ulna should be determined in different positions of the forearm. The **ulnar nerve** can be felt between the medial epicondyle and the olecranon. The head of the radius, which should be rotated in order that its relation to the epicondyle may be better appreciated, should be palpated below the lateral epicondyle. The rounded posterior surface of the arm is formed by the **triceps** muscle. In the forearm

the radius can be but little felt, except at its lower extremity, but the olecranon process and sharp posterior margin of the ulna can always be recognised, even in very muscular subjects. The tendon of the biceps may be felt as it passes across the antecubital fossa towards its insertion. It should be observed that the ulna is the more prominent of the two bones at the wrist, especially as seen from the back, but that the end of the radius extends a little lower down than that of the ulna, the **styloid process** of each bone being readily felt. The tendons of the **flexor carpi radialis** and **flexor carpi ulnaris** are usually to be felt near the wrist, and serve as guides to the **radial** and **ulnar arteries** which lie, respectively, to the lateral (or radial) side of each tendon.

The superficial fascia being displayed, the cutaneous structures, the cutaneous nerves and the superficial veins (Figs. 11 and 12) are to be dissected out. Commence at the lower part of the arm by securing the **cephalic** and **basilic** veins in the lateral and medial bicipital sulcus respectively, and trace them upwards and then downwards towards the elbow, and from there follow out their tributaries. On the medial side of the arm, the **medial cutaneous** nerve of the **forearm** will be found close to the lower part of the basilic vein. Higher up, the **medial cutaneous** nerve of the **arm** and the **intercosto-brachial** nerve are to be traced downwards from the axilla where their cut ends are secured. Near the lower end of the cephalic vein, and emerging from under the biceps tendon, the **lateral cutaneous** nerve of the **forearm** should be found, and above and lateral to this the **dorsal cutaneous** branches of the musculo-spiral nerve should be secured close to the insertion of the deltoid and traced on to the back of the forearm. There is a **bursa** over the olecranon which should be examined; it is frequently the seat of inflammation. The deep fascia is to be left intact throughout the whole dissection.

The **Superficial Veins** (Fig. 11).—The **median** vein arises in a plexus just above the wrist, and runs upwards more or less in the centre of the front of the forearm. Below the elbow it receives the **profunda** vein (which pierces the deep fascia and communicates with the venæ comites of the radial and ulnar arteries), and immediately afterwards divides into two branches, which pass obliquely upwards. The outer branch is the **median cephalic** and the inner is the **median basilic** vein. The median cephalic vein, the smaller branch, crosses the tendon of the biceps muscle and (as a rule) the lateral cutaneous nerve of the forearm, and having received the superficial (radial) veins (two or three in number) of the radial side of the forearm ascends on the lateral side of the biceps and then between the pectoralis major and the deltoid muscles as the **cephalic** vein. It has already been traced to its termination in the axillary vein. The

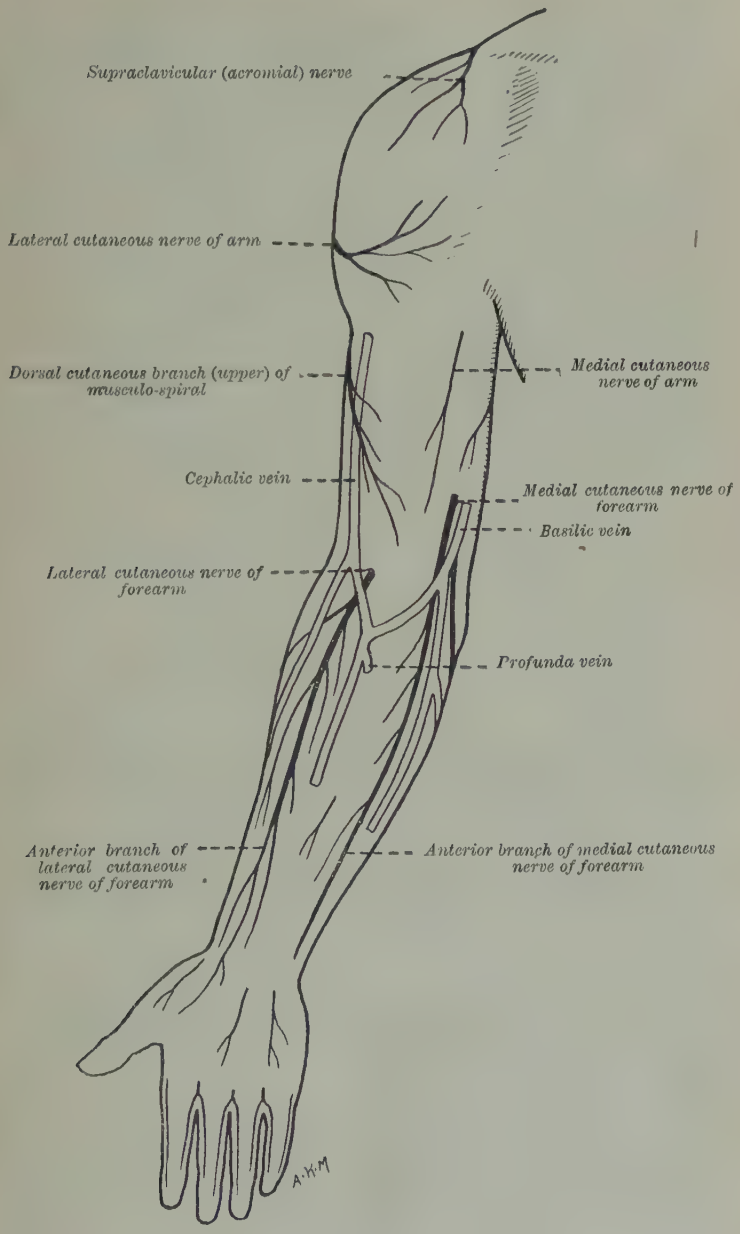
Supraclavicular (acromial) nerve
Lateral cutaneous nerve of arm
Dorsal cutaneous branch (upper) of musculo-spiral
Medial cutaneous nerve of arm
Cephalic vein
Medial cutaneous nerve of forearm
Basilic vein
Lateral cutaneous nerve of forearm
Profunda vein
Anterior branch of lateral cutaneous nerve of forearm
Anterior branch of medial cutaneous nerve of forearm
A.H.M

FIG. 11.

The cutaneous nerves and the superficial veins of the front of the upper limb.

median basilic vein is a short wide trunk, and is usually selected for venesection on account of its position and size; its relations are therefore important. It runs upwards and medialwards over the fibrous expansion of the biceps (bicipital fascia) which separates it from the brachial artery, and passes either over or under the medial cutaneous nerve of the forearm. Having received the superficial (ulnar) veins of the medial side of the forearm, it continues as the basilic vein on the medial side of the biceps to about the middle of the arm, where it pierces the deep fascia. It continues upwards for a short distance on the medial side of the brachial artery, and having received the venæ comites of that vessel at a variable point in the axilla, runs onwards as the **axillary** vein.

To the medial side of the basilic vein, about an inch above the epicondyle, there is a small lymphatic gland, the epicondylar gland.

The superficial veins of the back of the forearm drain into the median basilic and median cephalic veins, and those of the arm into the branches of the brachial venæ comites.

It should be mentioned that the arrangement of the superficial veins is very variable and may not correspond to the above description.

The **cutaneous nerves** (Figs. 11 and 12) of the arm and forearm are numerous, but are all derived from the brachial plexus. They are best classified in two groups; those distributed to the medial side and those distributed to the lateral side of the limb.

Medial Group.	Lateral Group.
Intercosto-brachial nerve.	Lateral cutaneous nerve of **arm.**
Dorsal cutaneous nerve of **arm.**	Dorsal cutaneous nerves of **forearm.**
Medial cutaneous nerve of **arm.**	Lateral cutaneous nerve of **forearm.**
Medial cutaneous nerve of **forearm.**	

Medial Group.—The **dorsal cutaneous** nerve of the **arm** is a branch of the musculo-spiral, and appears on the medial side below the teres major. It inclines backwards, deep to the intercosto-brachial nerve, and is distributed on the medial and posterior aspects of the arm as far as the elbow. The **intercostal-brachial** nerve can be traced half-way down the arm. The **medial cutaneous** nerve of the arm, after joining with the intercosto-brachial, pierces the deep fascia at a variable point, and supplies the lower third of the medial side of the arm. The **medial cutaneous** nerve of the **forearm** is to be followed downwards from the medial cord of the brachial plexus. It lies at first on the medial side of the axillary and then of the brachial artery, but perforates the deep fascia about the middle of the arm, and proceeds distally in front of the medial cutaneous nerve of the arm, and close to the basilic vein. It divides into two branches, which pass in front of the medial epicondyle of the humerus and either over or under the median basilic vein, and are distributed on the ulnar side of the forearm on its volar and dorsal aspects respectively.

Lateral Group.—The skin over the shoulder is supplied by the acromial group of the supraclavicular nerves; and below this, and over the deltoid, by the lateral cutaneous nerve of the arm, a branch of the circumflex nerve, already dissected as it emerges below the posterior border of the deltoid. The **dorsal cutaneous** nerves of the **forearm** (usually two in number) are branches of the musculo-spiral nerve, and

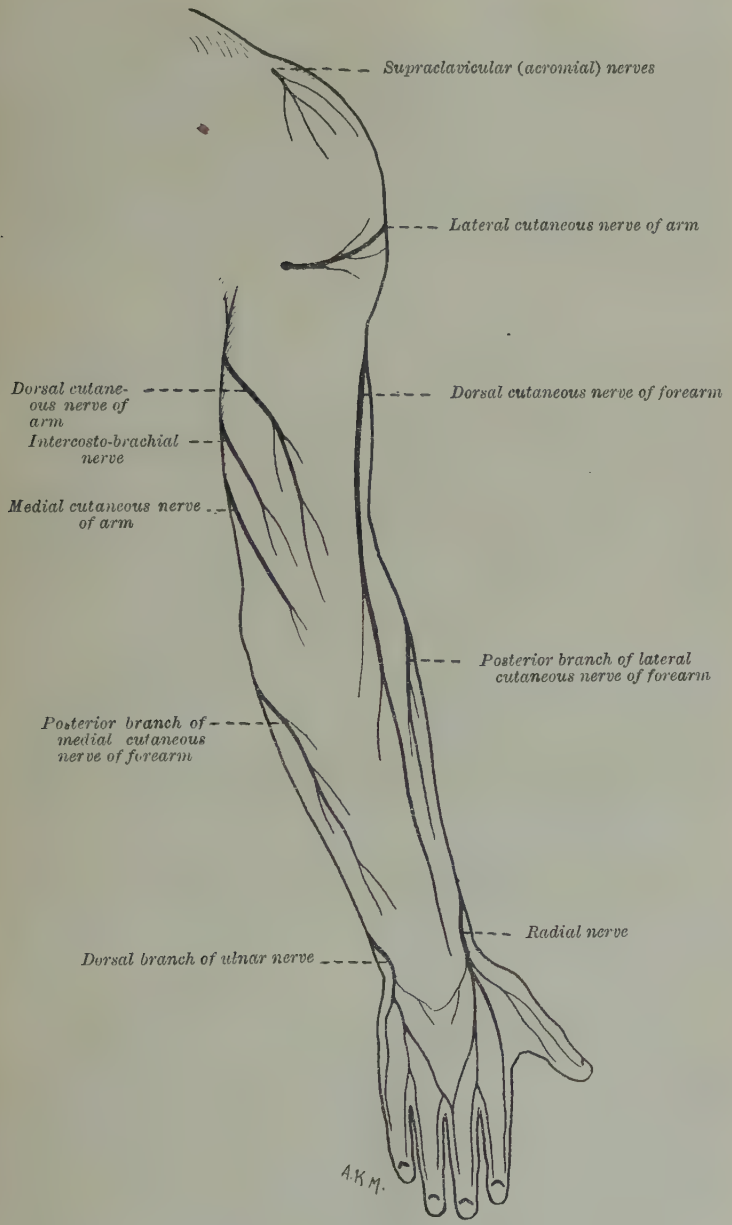
Supraclavicular (acromial) nerves
Lateral cutaneous nerve of arm
Dorsal cutaneous nerve of arm
Intercosto-brachial nerve
Medial cutaneous nerve of arm
Dorsal cutaneous nerve of forearm
Posterior branch of lateral cutaneous nerve of forearm
Posterior branch of medial cutaneous nerve of forearm
Radial nerve
Dorsal branch of ulnar nerve
A.K.M.

FIG. 12.

The cutaneous nerves of the back of the upper limb.

pierce the deep fascia just below the insertion of the deltoid, and close to the lateral intermuscular septum. The upper branch is the smaller, and follows the cephalic vein as far as the elbow. The lower branch can be followed behind the lateral epicondyle of the humerus and as far as the wrist joint on the back of the forearm, the skin of which it supplies on the lateral side. The **lateral cutaneous** nerve of the **forearm** is the terminal branch of the musculo-cutaneous nerve. It pierces the deep fascia in front of the elbow joint on the lateral side of the tendon of the biceps muscle, and runs downwards under the median cephalic vein. It divides into two main branches and supplies the skin on the radial side of the forearm as far as the wrist joint on its volar and dorsal aspects.

THE FRONT OF THE ARM

The superficial fascia over the front of the arm is to be removed, the cutaneous structures being preserved and turned aside, so that the rather weak **deep fascia** of this region may be cleaned. This fascia is continuous above with the axillary fascia and with that covering the deltoid, while below and posteriorly it is firmly fixed to the bony prominences round the elbow. In front of the elbow, just over the antecubital fossa, it receives the insertion of an aponeurotic band (**bicipital fascia**) from the tendon of the biceps muscle, and is continued below into the fascia of the forearm. The deep fascia should now be reflected, but the muscles of the front of the arm are not to be disturbed in position. The dissector should recognise at once the **medial** and **lateral intermuscular septa**, two strong processes of deep fascia, one on either side, which intervene between the muscles of the front and back of the arm and which are fixed deeply to the bone. The medial septum (Fig. 13) is the stronger, and is attached to the medial supracondylar ridge of the humerus, and reaches as high as the insertion of the coraco-brachialis muscle: the lateral septum is fixed to the lateral supracondylar ridge, and may be traced upwards to the insertion of the deltoid. These septa divide the arm into anterior and posterior compartments, and it is on the dissection of the anterior compartment that the student is now engaged.

The axillary nerves and vessels should be arranged and tied in their proper relations to one another and fixed to the coracoid process. The dissection of the entire length of the **brachial** artery (Fig. 13) should then be carried out, and its branches are to be cleaned so far as they lie in the front of the arm, while its terminal branches, the **radial** and **ulnar** arteries, are to be seen. All the brachial nerves will be found in relation to the artery in at least a part of their course, and are so far to be followed out. The muscles

should be left undisturbed till this part of the dissection is completed, so that the relation of the artery to them may be thoroughly appreciated. The muscles of the front of the arm are the **biceps** placed superficially, and extending from the scapula into the forearm; the **coraco-brachialis** lying along the upper part of its medial margin; and deep to the biceps, applied to the front of the humerus, is the **brachialis**. Two muscles of the forearm, the **brachio-radialis**, and below it the **extensor carpi radialis longus**, will be seen extending upwards to the lateral supracondylar ridge, but they should be left undisturbed.

The **brachial artery** (Fig. 13) is the direct continuation of the axillary, and extends from the lower border of the teres major to the antecubital fossa, where at the level of the neck of the radius it bifurcates into the radial and ulnar arteries. The artery is superficial, or at least is crossed by no muscle, in the whole of its course, but may be overlapped by a well-developed biceps. In direction it gradually turns forwards from the medial side of the arm above to the middle of the bend of the elbow below. The artery lies under the skin and fasciæ, somewhat overlapped by the medial margin of the biceps, and at the bend of the elbow it is crossed by the bicipital fascia which separates it from the median basilic vein. It rests behind, first on the long head of the triceps (the musculo-spiral nerve intervening), and then upon a small portion of the medial head of the triceps; next, on the insertion of the coraco-brachialis, and afterwards upon the brachialis muscle for the rest of its course. The median nerve lies along the lateral side of the artery above, but about the middle of the arm crosses over (sometimes under) the vessel and runs along its medial side to its termination. The ulnar nerve and the medial cutaneous nerve of the arm are in close contact with the medial side of the vessel above, but soon leave it; the ulnar to pass backwards through the medial intermuscular septum, and the medial cutaneous nerve perforating the deep fascia to become superficial. The musculo-spiral nerve is behind the upper part, but leaves the artery by passing into the interval between the medial and lateral heads of the triceps. The position of the basilic vein is on the medial side of the artery throughout its course, but it comes into contact with the artery only in its upper part, *i.e.*, after piercing the deep fascia. Venæ comites are applied to the sides of the artery in its whole length, and are connected together by numerous transverse branches. They ultimately unite with the basilic to form the axillary vein.

The **branches** of the **brachial** artery are—(1) a series of **muscular** branches which arise at various points from its lateral side and supply the muscles of the front of the arm. (2) The **profunda** artery, the largest branch, which comes off just below the teres major, and associating itself with the musculo-spiral nerve, passes between the medial and lateral heads of the triceps to the back of the arm. (3) The **ulnar collateral** artery which takes origin at a variable distance below the preceding, or in common with it, and passes with the ulnar nerve through the medial intermuscular septum. It runs downwards behind the septum to the interval between the olecranon and the medial condyle of the humerus. (4) The **nutrient** artery of the humerus, which should be sought for opposite the lower end of the insertion of the coraco-brachialis

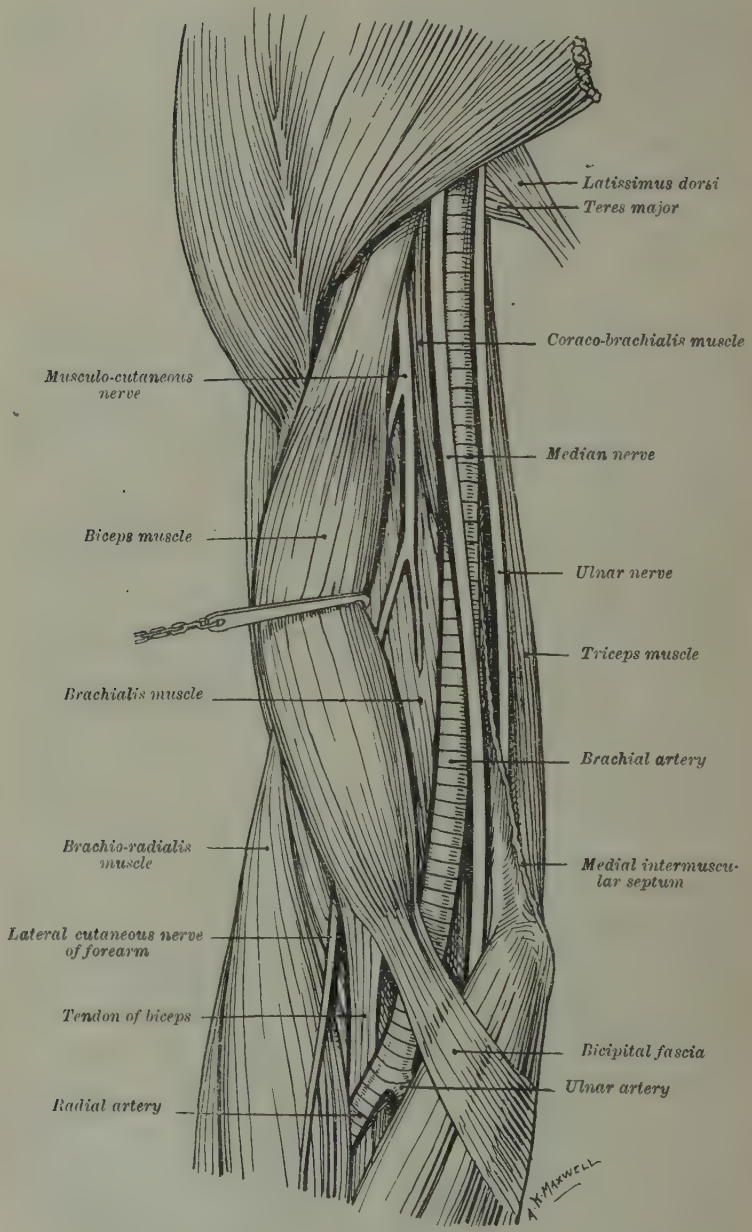

FIG. 13.

Dissection of the front of the arm. (The venæ comites of the brachial artery are not shown.)

and traced into the nutrient foramen of the bone. In some cases this vessel will be found on the back of the arm arising from the profunda. (5) The **anastomotic** (a. collateralis ulnaris inferior) which arises about two inches above the bend of the elbow and runs directly medialwards on the brachialis muscle. It gives off a small anterior branch which descends along the lateral edge of the pronator teres muscle of the forearm and joins the anterior ulnar recurrent artery ; and terminates as a larger posterior branch which pierces the medial intermuscular septum and descends behind the medial epicondyle and joins the ulnar collateral and posterior ulnar recurrent arteries.

(*Note.*—The brachial artery so frequently does not conform to the above description, that it is right that the student should know of the more common variations. The point of bifurcation is sometimes much higher than the bend of the elbow, or the brachial may consist of two trunks from its commencement, the division having taken place in the axilla. Occasionally there is an axis common to all the principal branches ; and sometimes a **vas aberrans** passes from the brachial across the median nerve to join the radial (or more rarely the ulnar) below. The artery, with the median nerve, sometimes passes through a fibrous canal under a process of bone, the **supracondylar** process, above the median epicondyle.)

The muscles proper of the front of the arm are now to be cleaned and their attachments defined as far as is directed in their description below. The **musculo-cutaneous** nerve is to be followed out in its whole course, and its branches to these muscles are to be secured. The fascia on the upper part of the forearm should not be disturbed.

The **biceps** (Figs. 4 and 13) is the superficial muscle. It arises by two heads which unite with one another in the upper third of the arm. The **long** head, not to be fully traced at present, is attached within the capsule of the shoulder joint to the top of the glenoid cavity and to the glenoid ligament (Fig. 16). The tendon traverses the joint, enclosed in a sheath of synovial membrane, and enters the bicipital groove of the humerus, where, having emerged from the capsule, it is seen to lie between the insertions of the pectoralis major and teres major muscles. The **short** head springs from the tip of the coracoid process in common with the coraco-brachialis. The two heads unite to form a large fleshy belly, the fibres of which converge to a rounded tendon, from which there is given off immediately above the elbow joint an aponeurotic expansion, the bicipital fascia, inserted into the deep fascia on the upper and inner part of the forearm. This will have to be divided, in a later dissection, in order to follow out the tendon of the biceps, which passes deeply into the antecubital fossa to be inserted into the posterior part of the bicipital tubercle of the radius, a bursa being placed between the tendon and the smooth anterior surface of the tubercle. It will be seen better in a later dissection. The tendon becomes flattened near its insertion, and is twisted on itself so that its lateral edge becomes anterior.

The **coraco-brachialis** arises from the tip of the coracoid process, in common with, but to the medial side of, the short head of the biceps. It is pierced by the musculo-cutaneous nerve, which has previously given

off branches for its supply. It is inserted into the medial side of the shaft of the humerus about its middle, and is there crossed by the brachial artery.

The **brachialis** muscle (Fig. 13) arises from the front of the shaft of the humerus in its lower half by a bifid origin which embraces the insertion of the deltoid, and it is also attached to the front of the medial and lateral intermuscular septa. It is inserted into a rough triangular impression on the front of the coronoid process of the ulna. It covers the front of the capsule of the elbow joint, and is intimately connected with its anterior ligament. A considerable portion of the muscle appears superficially on the lateral side of the arm between the biceps and triceps, but it is covered in front by the biceps, and is overlapped below by the brachio-radialis and extensor carpi radialis longus on its lateral side and the pronator teres on its medial side. It is the direct posterior relation of the lower part of the brachial artery. It is supplied mainly by the musculo-cutaneous nerve, but it also receives one or two small twigs from the musculo-spiral nerve, which are given off under cover of the brachio-radialis.

The great **nerves** which supply the muscles and are distributed to the skin of the arm, forearm, and hand, have already been secured at their origins from the cords of the brachial plexus. They enter the front of the arm lying round the upper part of the brachial artery, and are now to be followed in their course through the region under dissection. The **musculo-cutaneous** nerve is to be dissected first. It supplies the three muscles proper to the front of the arm. The **median** and **ulnar** nerves are also distributed to the anterior muscles of the limb, the former supplying most of those of the front of the forearm, and the latter nerve most of those of the palm of the hand. The **musculo-spiral** nerve is distributed entirely on the dorsal side of the limb, supplying through its branches the posterior muscles of the arm and forearm; (there are no muscles proper to the back of the hand).

The **musculo-cutaneous nerve** (Fig. 13) arises from the lateral cord of the brachial plexus in common with the lateral head of the median. For a short distance it lies to the lateral side of the median nerve and the lower part of the axillary vessels. It then pierces the coraco-brachialis muscle obliquely, after having given branches to it, and comes to lie between the biceps and the brachialis muscles, both of which it also supplies. It finally becomes cutaneous at the lateral side of the tendon of the biceps, just above the bend of the elbow, as the lateral cutaneous nerve of the forearm, which has already been followed beneath the median-cephalic vein, and traced to its cutaneous distribution.

The **median nerve** (Fig. 13) is derived from the lateral and medial cords of the brachial plexus by two heads which unite on the lateral side of the axillary artery in the third part of its course. The nerve retains the same relation to the brachial artery for about half its length; then, crossing over (or occasionally under) that vessel, lies to its medial side, and continues in this relation to the bend of the elbow. It gives off no branch in the arm until it reaches the level of the medial epicondyle,

where a small twig is detached for the supply of the pronator teres. It is usually connected with the musculo-cutaneous nerve just beyond its formation.

The **ulnar nerve** (Fig. 13) is a branch of the medial cord of the brachial plexus, and was first isolated close to the medial side of the axillary artery. It lies afterwards in a similar relation with the upper part of the brachial artery, but it leaves that vessel about the middle of the arm by passing backwards through the medial intermuscular septum. Accompanied by the ulnar collateral artery, it runs downwards behind that septum to the interval between the medial epicondyle and the olecranon process. The ulnar nerve gives off no branches in the arm.

The **musculo-spiral nerve** is the continuation of the posterior cord of the brachial plexus, and lies at first behind the axillary artery, and upon the subscapularis muscle. It then rests upon the latissimus dorsi and teres major, where it gives off the dorsal cutaneous nerve of the arm (already secured). It enters the arm behind the brachial artery, but almost at once passes backwards between the medial and lateral heads of the triceps accompanied by the profunda brachii artery ; and, lying in the musculo-spiral groove, crosses the back of the humerus from the medial to the lateral side of the arm. It here gives off the two dorsal cutaneous nerves of the forearm (already secured), and having pierced the lateral intermuscular septum, it runs down the front of the arm between the brachio-radialis and the brachialis muscles, to both of which it gives branches. It should be secured in this interval, and traced to its division, just below the lateral epicondyle of the humerus, into a cutaneous nerve, the **radial**, and the **posterior interosseous** nerve, which pierces the supinator muscle to reach the back of the forearm. Muscular branches to the triceps, anconeus, and extensor carpi radialis longus muscles will be seen in a subsequent dissection.

ANTECUBITAL FOSSA

The muscular boundaries of this fossa (Fig. 14) are now to be exposed by dividing the bicipital fascia and removing the deep fascia from the upper parts of the muscles of the forearm. The tendons of the biceps and brachialis are to be thoroughly cleaned, and the fibres of the **supinator** muscle in the floor of the space are to be defined. The termination of the brachial artery and the median nerve are to be cleaned in the middle line, and at the lateral side of the space, between the brachialis and brachio-radialis muscles, there are to be defined the bifurcation of the musculo-spiral nerve, and an anastomosis between the profunda brachii and the **radial recurrent** arteries. At the medial side, an anastomosis between the anterior branch of the anastomotic and the **anterior ulnar recurrent** arteries is to be found on the surface of the brachialis.

The **antecubital fossa** is described as a triangular space, bounded above by an imaginary line drawn across the arm between the humeral epicondyles ; and two inches below the elbow joint, the

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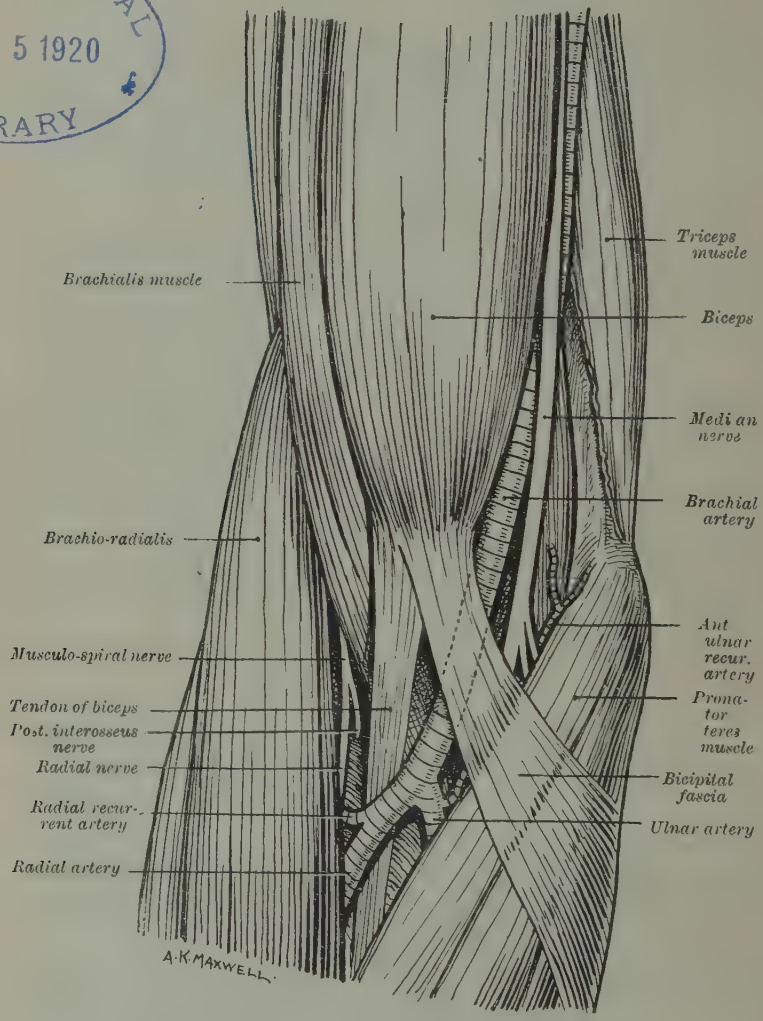


FIG. 14.

Dissection of the antecubital fossa.

apex is formed by the meeting of the **pronator teres** and brachio-radialis muscles. The lateral boundary is the brachio-radialis, the medial the **pronator teres**, whilst the floor is formed by the lower part of the brachialis; lateral to this, when the brachio-radialis is drawn aside, there may be seen the oblique fibres of the **supinator** muscle. The relations of the superficial veins and nerves have been already examined, and the contents of the space are now seen to be the median nerve, the brachial artery, and the tendon of the biceps —in that order from the medial to the lateral side. The median nerve runs almost vertically through the space, and disappears between the heads of the pronator teres, and the brachial artery bifurcates into its radial and ulnar branches upon the insertion of the brachialis. The radial artery rests against the tendon of the biceps and the supinator, and the ulnar lies upon the brachialis till it disappears beneath the pronator teres. By slightly displacing the brachio-radialis outwards, the musculo-spiral nerve will be seen lying between it and the brachialis, and dividing there into **radial** and **posterior interosseous** nerves. The radial nerve may be seen for a short distance upon the supinator, whilst the posterior interosseous to the medial side of the radial, can be traced into the fibres of that muscle.

THE BACK OF THE ARM

The forearm is to be bent on the arm, which is to be placed on the table with the back upwards. The student should recognise again the cutaneous nerves of this region (Fig. 12), and then remove the superficial and deep fasciæ from the **triceps**, the single muscle of the back of the arm, which is now to be studied. He should note again the large bursa superficial to the olecranon process of the ulna.

The **triceps muscle** (Figs. 10, 12, and 15) occupies the whole of the posterior compartment of the arm. It has three heads—the long or scapular head, and the medial and lateral humeral heads. The long head arises from a somewhat triangular rough surface on the axillary border of the scapula immediately below the glenoid cavity. It has already been partly examined both from the front and from behind, and was found to lie between the teres minor and subscapularis muscles, and to separate the insertions of the teres major and minor muscles from one another. It joins the lateral head at the junction of the upper and middle thirds of the arm. The lateral head arises from the upper part of the lateral side of the posterior surface of the humerus as far down as the musculo-spiral groove, and from a tendinous arch thrown over the groove. The medial head arises from the whole of the posterior surface of the humerus below the musculo-spiral groove and to within half an

inch of the elbow joint. The whole of the fibres of the muscle converge to a strong tendon which is inserted into the back part of the upper surface of the olecranon process, and into the deep fascia of the forearm through which it is fixed to the posterior border of the ulna. A few of the deeper fibres are attached to the capsule of the elbow joint, and form what has been termed the **subanconeus** muscle. A small bursa intervenes between the main tendon and the olecranon.

The handle of a knife is to be passed along the musculo-spiral groove, and along the line thus indicated the fibres of the lateral head of the triceps are to be divided; and with the long head of the muscle this part is to be separated from the medial head, and the whole length of the musculo-spiral groove thus displayed. The **musculo-spiral** nerve and the **profunda brachii** artery are now to be followed in their course across the bone and on to the front of the arm.

The **musculo-spiral nerve** (Fig. 15) has already been found to be a branch of the posterior cord of the brachial plexus, and was traced on the front of the arm to its disappearance between the lateral and medial heads of the triceps. It can now be followed in the musculo-spiral groove across the back of the humerus between these heads of the muscle, and then forwards through the lateral intermuscular septum, until it reaches the interval between the brachio-radialis and brachialis, where its terminal divisions, the **radial** and **posterior interosseous** nerves, have already been secured. It gives off in its course on the back of the arm, numerous large branches to the triceps and a branch to the **anconeus** muscle, and afterwards, in the antecubital fossa, gives off branches to the brachio-radialis and the extensor carpi radialis longus, and a small twig which supplies, in part, the brachialis. The branch to the anconeus is given off high up in the musculo-spiral groove, and should be traced through the fibres of the medial head of the triceps to the back of the lateral epicondyle. The branch to the medial head of the triceps is known as the "ulnar collateral nerve," because it descends in close relation with the ulnar nerve. The cutaneous branches of the musculo-spiral have been secured in a previous dissection.

The **profunda** branch of the brachial artery (Fig. 15) accompanies the musculo-spiral nerve across the humerus, and supplies the triceps in its course. A branch ascends beneath the triceps muscle to anastomose with the posterior humeral circumflex artery. At the lateral edge of the triceps the profunda brachii divides into two branches, anterior and posterior. The posterior, the larger branch, runs down the back of the arm beneath the triceps close to the lateral intermuscular septum and anastomoses with the recurrent branch of the posterior interosseous artery. The anterior branch, usually of small size, runs with the musculo-spiral nerve to the front of the arm, and between the brachio-radialis and brachialis anastomoses with the radial recurrent artery.

The dissector should now follow out the **ulnar nerve**, accompanied by the ulnar collateral artery, in that part of its course on the posterior surface of the medial intermuscular septum, and observe that it is covered by a thin layer of the medial head of the

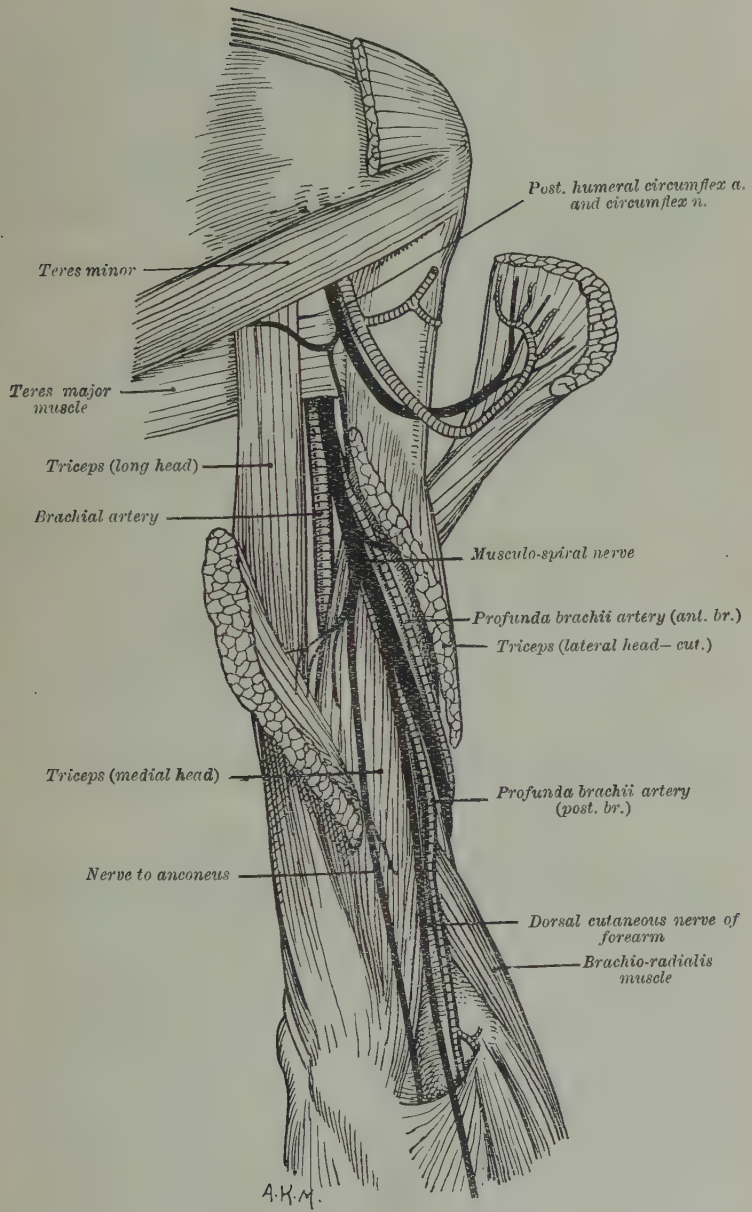


FIG. 15.

Dissection of the back of the arm. (The lateral head of the triceps has been divided.)

triceps. He should dissect out the ulnar collateral and the posterior division of the anastomotic arteries behind the medial epicondyle of the humerus, and behind the lateral epicondyle, the posterior branch of the profunda brachii. A transverse anastomoses between these medial and lateral descending vessels can usually be found crossing the humerus under the triceps, which should be divided just above the olecranon. The **subanconeus** fibres may now be displayed, and below the tendon, the bursa between it and the upper part olecranon.

THE SHOULDER JOINT

Before the dissection of the forearm is commenced, it is advisable to study the shoulder joint.

The dissector should note again, in the first place, how the joint is surrounded and supported by the scapulo-humeral muscles; above by the supraspinatus, in front by the subscapularis, behind by the infraspinatus and teres minor, and below, but only to the slightest extent, by the long head of the triceps. These muscles must now be removed, and it will be found that though they are in close connection with the ligamentous capsule of the joint, they do not form an integral part of that structure, and can therefore be dissected from it. Under the subscapularis the bursa, already described, will be found; it communicates practically always with the joint cavity. The conjoined origin of biceps and coraco-brachialis from the coracoid process, the teres major and the long head of the triceps are to be divided, and the articular capsule should now be cleaned.

The **articular capsule** (Fig. 16) of the shoulder joint is remarkably lax, so that, the surrounding muscles now being divided and the joint cavity open through the subscapularis bursa, the joint surfaces may be separated to the extent of one inch. It is attached above round the margin of the glenoid cavity, but only directly to the bone at its upper margin, elsewhere being fixed to the **glenoid** ligament. Below it is attached to the anatomical neck of the humerus. It is perforated under the subscapularis muscle, where the joint cavity communicates with the subscapularis bursa; and between the two tuberosities of the humerus it bridges over the bicipital groove, leaving an aperture for the exit of the long tendon of the biceps from its interior. The capsule is thickened at certain parts in the form of capsular ligaments; above as the **coraco-humeral** ligament and anteriorly as the **gleno-humeral** ligaments. The coraco-humeral ligament passes from the lateral side of the root of the coracoid process to the tuberosities of the humerus, where it bridges over the bicipital groove. The gleno-humeral ligaments are to be seen only from the interior of the capsule, which should be divided on its posterior aspect for this purpose. The superior ligament, narrow and rounded, is attached to

the upper part of the glenoid margin, just in front of the origin of the long head of the biceps, and below, is fixed to the lesser tuberosity. The inferior ligament, broader and stronger, runs from the lower half of the anterior glenoid margin to the anterior and inner side of the anatomical neck of the humerus.

The tendon of the biceps is to be followed into the articulation by completing the division of the capsule. It will be seen to pass over the head of the humerus to the upper part of the glenoid

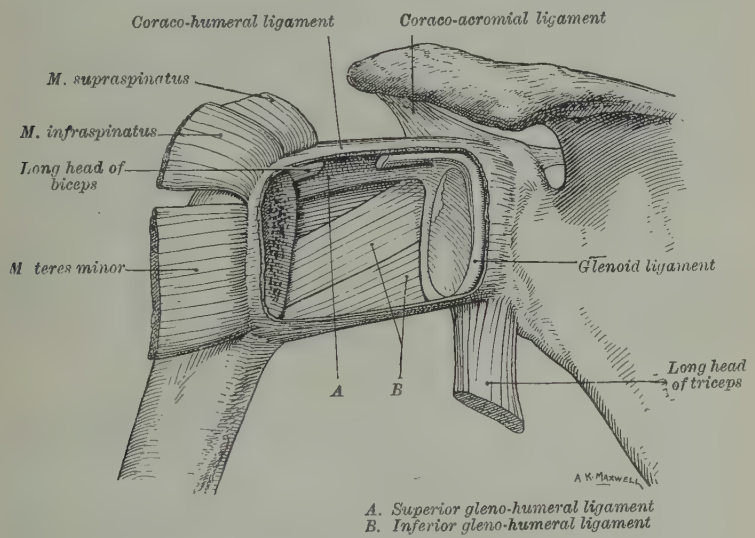


FIG. 16.

Dissection of the shoulder joint. (The capsule of the joint has been opened from behind and the head of the humerus removed.) After Quain.

cavity, where its attachment to the bone and the glenoid ligament is to be defined.

The **glenoid ligament** (labrum glenoidale) is a fibro-cartilaginous ring fixed around the bony rim of the glenoid cavity. It gives attachment to the long tendons of the biceps and triceps. There is a single **synovial membrane** in the shoulder joint, which is reflected over the glenoid and capsular ligaments and ensheaths the tendon of the biceps in its passage through the shoulder joint and even beyond its exit from the capsule.

THE FRONT OF THE FOREARM

The superficial dissection of the front and the back of the hand is to be associated with the dissection of the front of the forearm.

Surface Anatomy—The **styloid** processes of the radius and ulna are subcutaneous, and the student should note carefully that the tip of the radius reaches lower than the tip of the ulna. Below and medial to the radial process, the tubercle of the **navicular** bone of the carpus can be palpated, and below the ulnar process the **pisiform** bone can readily be felt and moved about. The fleshy swelling above the thumb is termed the **thenar** eminence, and that above the little finger on the medial margin of the palm is the **hypothenar** eminence. The positions of the various joints of the fingers should be carefully determined from behind, and it will be observed that they do not exactly correspond with the transverse markings on the skin in front.

An incision is to be made down the centre of the palm of the hand and joined by a transverse incision across the roots of the fingers. The flaps of skin thus marked out should be reflected. The **superficial fascia** of the palm appears granular, and contains a considerable amount of tough fibrous tissue. It is very thin over the thenar and hypothenar eminences. The skin of the dorsum of the hand should now be raised as far as the knuckles. The **cutaneous** nerves of both surfaces of the hand are to be examined.

The **cutaneous nerves** of the forearm have already been examined, the medial cutaneous, the lateral cutaneous, and the dorsal cutaneous, having been found, respectively, on those aspects of the limb indicated by their names. The **palmar** cutaneous nerves (Fig. 11) are small branches of the radial, median, and ulnar nerves, and are somewhat difficult to secure. (The branch from the radial is not constant.) They arise in the forearm, but pierce the deep fascia only just above the wrist, and end in the skin of the palm in positions which are sufficiently indicated by their names.

The cutaneous nerves of the **dorsum** of the hand (Fig. 12) are derived from those branches of the radial and ulnar nerves which supply the backs of the fingers. The main trunks only should be secured at present. The dorsal branch of the ulnar nerve emerges through the deep fascia just above the wrist, and winds round the lower end of the ulna on to the dorsum of the hand. There it breaks into three branches, which give off twigs to the skin on the hand, and will afterwards be traced to the little and ring fingers. The radial nerve winds round the radius about two inches above its styloid process, under cover of the tendon of the brachio-radialis. It breaks into branches for the backs of the remaining fingers, and from these, fine filaments are given to the skin on the dorsum of the hand.

The superficial veins and cutaneous nerves of the front of the forearm being turned aside, the **deep fascia** of this region is to be cleaned by removal of any remaining superficial fascia. The deep fascia of the forearm is a strong fibrous layer, and in its upper

part, near the elbow, serves as an origin for the superficial group of the muscles of the forearm. From its deep surface septa pass between the muscles, and these are indicated on its surface, in a thin subject, by a series of longitudinal white lines. At the wrist it becomes continuous in front with the **anterior carpal ligament**, and posteriorly it forms a thickened band, the **posterior carpal ligament**. It must now be removed from the front of the forearm, but near the elbow should be left on the muscles which arise from it. At the wrist the anterior carpal ligament is not to be disturbed.

The five muscles which are attached to the medial epicondyle of the humerus (Fig. 17) are to be cleaned, as far as is possible, without disturbing them. They form the superficial group of the muscles of the front of the forearm, a second group being placed deep to them. They are, beginning from the lateral side, the **pronator teres**, which is inserted on the lateral side of the radius, the **flexor carpi radialis**, the **palmaris longus** (which, however, may be absent), the **flexor digitorum sublimis**, the largest of the series, and the **flexor carpi ulnaris**; all of which, soon becoming tendinous, pass downwards towards the wrist. All of these muscles have a "common origin" from the humeral epicondyle and the deep fascia of the forearm, but three of them, the pronator teres, flexor digitorum sublimis, and flexor carpi ulnaris, have further secondary bony attachments. The flexor sublimis is primarily a flexor of the fingers, the flexors carpi radialis and ulnaris, and the palmaris longus, are direct flexors at the wrist, and the pronator teres is a pronator of the radius. All the muscles of the group, to a slight extent at least, are in addition flexors of the forearm on the arm. With the exception of the flexor sublimis, they should now be raised and completely dissected.

The **pronator teres** (Fig. 17) arises by a humeral head, in common with the other members of the group, from the medial epicondyle, and from about an inch of the supracondylar ridge; and by a deep head from the medial border of the coronoid process of the ulna. The median nerve passes between the two heads, and the ulnar artery beneath them. It is inserted by a broad tendon into the middle of the lateral side of the radius, immediately below the supinator muscle.

The **flexor carpi radialis** (Fig. 17) arises from the medial epicondyle, in common with the other muscles, and from the fascia of the forearm around it. It ends about the middle of the forearm in a tendon, which pierces the lateral attachment of the anterior carpal ligament, and passing through the groove in the trapezium is inserted into the base of the second, and slightly into the base of the third, metacarpal bone.

The **palmaris longus** (Fig. 17) arises from the common attachment to the medial epicondyle. Its long, slender tendon pierces the deep fascia, and passes superficial to the anterior carpal ligament; and

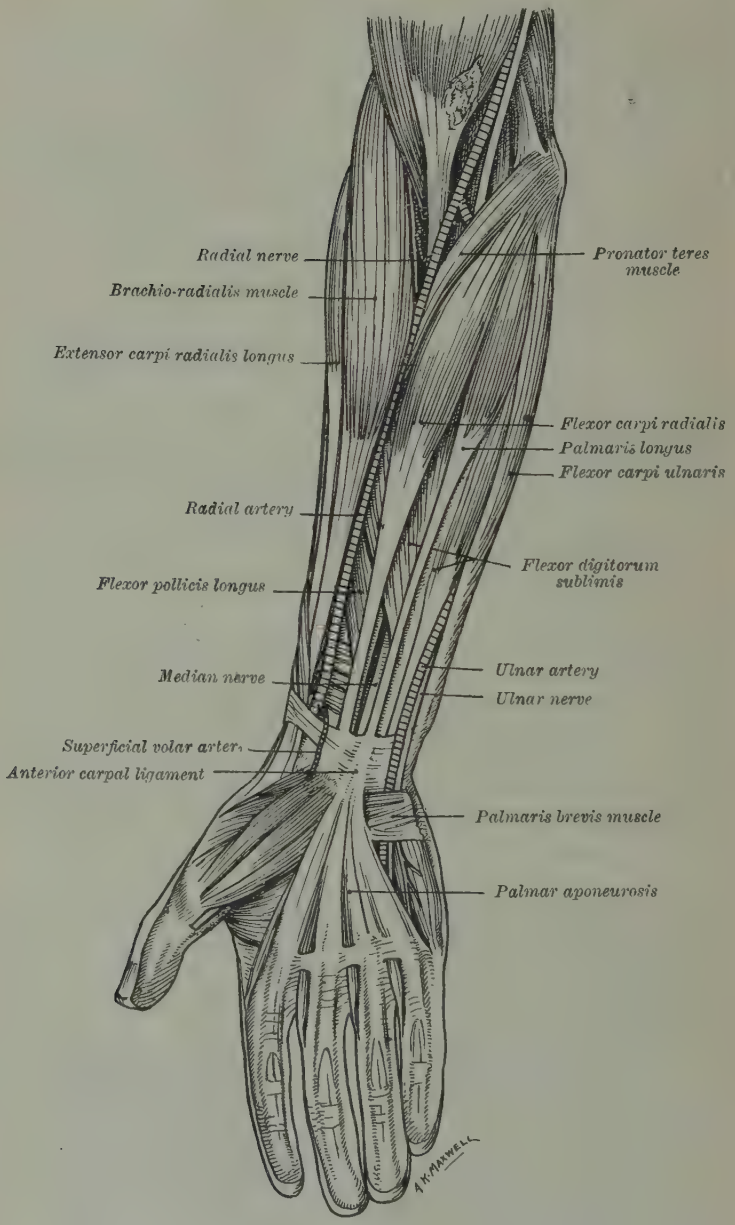


FIG. 17.

Dissection of the front of the forearm.

terminates by joining the palmar aponeurosis in the centre of the hand. The palmaris longus is subject to variation of its origin and insertion, and it is frequently wanting.

The **flexor carpi ulnaris** (Fig. 17) arises from the common humeral attachment, and by an additional aponeurotic origin from the medial side of the olecranon process, and from the upper two-thirds of the posterior border of the ulna. The muscle is inserted by a tendon into the pisiform bone, from whence it is prolonged by ligamentous bands to the unciform and the base of the fifth metacarpal bones.

The medial edge of the brachio-radialis, on the lateral side of the forearm, is to be defined, and the muscle belly drawn aside so as to expose the **radial artery**, and, in the upper two-thirds of the forearm, the **radial nerve**. These structures have then to be displayed in their whole course as they lie along the medial margin of the muscle.

The **radial artery** (Figs. 17 and 18) is the smaller of the divisions of the brachial, and extends from the bifurcation in the antecubital fossa along the lateral side of the forearm to the lower end of the radius, where it leaves the present dissection by turning on to the dorsum of the wrist. It is superficial in the whole of its course, except in its upper part, where it is overlapped from the lateral side by the brachio-radialis. It rests, from above downwards, on the following structures (which cover the front of the radius):—the tendon of the biceps, the spinator muscle, the insertion of the pronator teres, the thin radial origin of the flexor digitorum sublimis, the flexor pollicis longus, and the pronator quadratus; and lastly, it lies on the lower end of the radius itself. The flexor carpi radialis lies along its medial side, and the tendon of the brachio-radialis is lateral to it as far as the styloid process of the radius distal to which the artery passes to the dorsal aspect of the wrist. It is accompanied by two venæ comites throughout its length. The radial nerve lies on the lateral side of the artery in its middle third: in the upper third of the forearm the nerve is at some distance from the vessel, and in the lower third leaves the artery by passing dorsally under cover of the brachio-radialis. The radial artery gives off in the forearm (1) Numerous **muscular** branches along its whole length. (2) The **radial recurrent** artery, which runs laterally on the supinator muscle and over the epicondyle of the humerus, and anastomoses with the anterior branch of the profunda brachii. (3) The **superficial volar** artery, a variable branch, which arises near the root of the thumb, and runs distally among its short muscles. It often completes the **superficial palmar arch** by being continued into the palm of the hand. (4) The **anterior carpal** branch (a. carpi volaris radialis), a small artery, which runs across the wrist beneath the flexor tendons at the level of the lower border of the pronator quadratus, and joins a corresponding branch of the ulnar artery to form the **anterior carpal arch**.

The **radial nerve** (Fig. 18) has been seen to arise from the musculo-spiral at its division opposite the elbow under cover of the brachio-radialis. It lies at first upon the supinator, to the lateral side of, but at some little distance from, the radial artery. In the middle third of the forearm it is in close relation with the vessel, but leaves it in the lower third to pass beneath the tendon of the brachio-radialis to the

back of the forearm and hand, where it has already been secured. It is purely a cutaneous nerve, and on the front of the forearm the only branch given off is the variable small palmar cutaneous nerve.

The humeral head of the pronator teres is to be divided about its middle, without injuring the median nerve or the ulnar origin of the muscle, which is now to be thoroughly examined. The flexor carpi radialis and the palmaris longus are to be divided so as to expose the whole of the flexor sublimis, which is to be cleaned. The skin of the front of one of the fingers is to be removed (without further interfering with the palm), and in it the **fibrous sheath** (Figs. 17 and 19) of the flexor tendons is to be exposed. The **median nerve** is to be followed out from the elbow to the wrist, and its branches to the pronator teres, the palmaris longus, the flexor sublimis, and the flexor carpi radialis are to be secured.

The **flexor digitorum sublimis** (Fig. 17) lies rather deeper than the other superficial muscles. It arises from the common epicondylar attachment, and by a second head (a thin muscular sheet) from the oblique line on the front of the radius. Frequently it is also attached to the medial side of the coronoid process of the ulna above the pronator teres. The muscle ends in four tendons about half-way down the forearm, those of the middle and ring fingers lying in front of those of the index and little fingers, and all pass under the anterior carpal ligament. They are continued through the palm of the hand, and are attached to the second phalanges of the four fingers, but the manner of their insertion will be studied later. The tendon of the little finger is often of very small size.

The sublimis muscle is now to be divided below its origins, and its tendons tied together and turned downwards. The **deep group** of the muscles of the front of the forearm (Fig. 18) will now be exposed and are to be cleaned.

The **flexor pollicis longus** is the muscle on the radial side, the **flexor digitorum profundus** that on the ulnar side, while the **pronator quadratus** is the small transverse muscle lying deep to them above the carpus. The course of the **ulnar artery**, as far as the hand, will now be completely exhibited, and it will be seen to lie between the flexor carpi ulnaris and the most medial tendon of the flexor sublimis, and to rest on the flexor profundus. Its **common interosseous** branch, given off from its upper part, is to be secured at once; and lying along the medial side of the lower half of the vessel the **ulnar nerve** is to be found and traced upwards to behind the medial epicondyle, where it was previously displayed. The **anterior interosseous artery** and **nerve** (Fig. 18) should be exposed on the **interosseous membrane** by separating the flexor pollicis longus

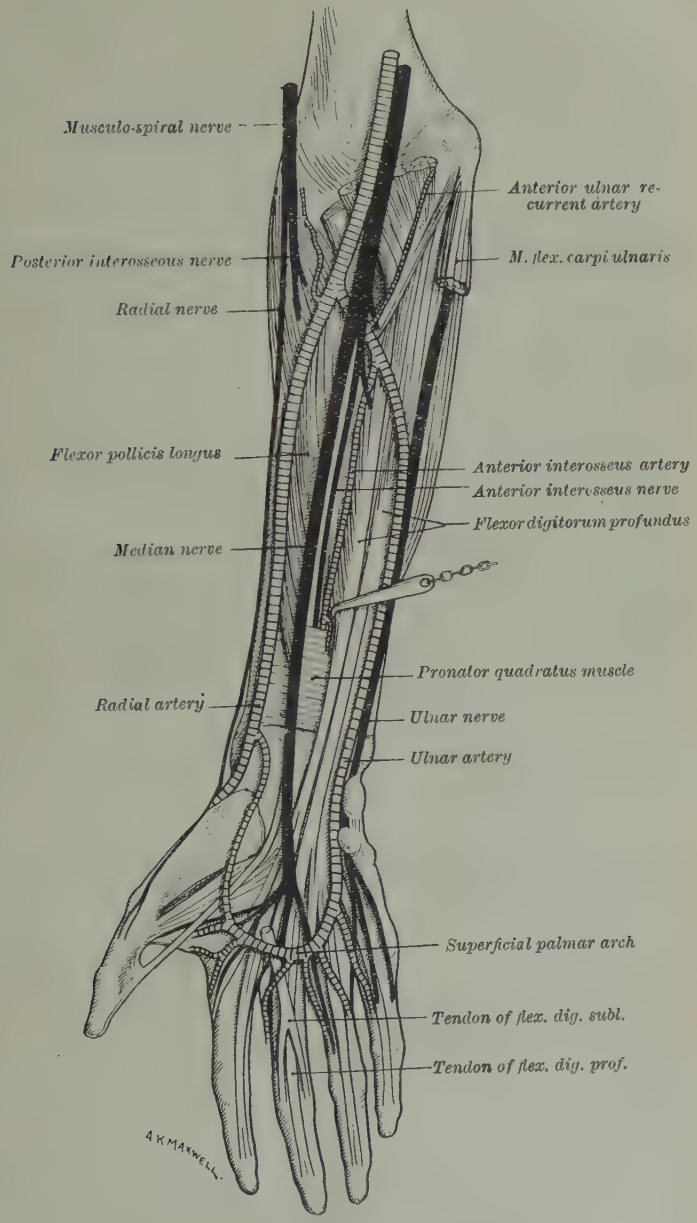


FIG. 18.
Deep dissection of the front of the forearm.

and the flexor digitorum profundus. The nerve is a branch of the median to which it should be traced.

The **flexor pollicis longus** (Fig. 18) arises from the whole of the anterior surface of the radius between the oblique line and the attachment of the pronator quadratus, and from the adjacent part of the interosseous membrane. It often has a small additional origin, by a slip of variable size, from the medial side of the coronoid process of the ulna, or even from the medial epicondyle of the humerus. The tendon passes beneath the anterior carpal ligaments and through the palm of the hand, to be inserted into the base of the terminal phalanx of the thumb.

The **flexor digitorum profundus** (Fig. 18) arises from the anterior and medial surfaces of the ulna, between the insertion of the brachialis and the origin of the pronator quadratus, and from the adjacent half of the interosseous membrane. The muscle ends in four tendons (that for the index finger alone being separated in the forearm), which pass under the anterior carpal ligament, and through the palm of the hand, to be inserted into the bases of the third phalanges of the four fingers.

To expose the insertions of the tendons of the flexor digitorum muscles, the fibrous tendon sheath (Fig. 17) of the finger dissected should be laid open along its centre. The sheath is formed by the first and second phalanges and the related joints of the digit, and by a fibrous arch (the vaginal ligament), which is very strong where it is attached to the lateral ridges of the phalanges, but is a thin expansion opposite the joints, where it is fixed to their ligaments. The osteo-fibrous sheath thus formed is lined by a synovial membrane, which is reflected from the bony wall upon the flexor tendons, and forms little synovial ligaments called **vincula**. These are of two kinds:—(1) Long thread-like bands passing from the phalanges to the tendons of the flexor sublimis and flexor profundus, vincula longa; and (2) short folds, one at the insertion of each tendon, vincula brevia. The tendon of the flexor sublimis will be seen to divide on the first phalanx into two slips, between which the tendon of the flexor profundus passes to its insertion on the base of the third phalanx (Fig. 18). The two slips of the sublimis tendon unite below the profundus tendon, forming for a short distance a bed for it, and then, dividing again, are inserted on the ridges at the sides of the second phalanx.

The **pronator quadratus** (Fig. 18), square shaped, arises from the lower part of the front of the ulna, and is inserted into the front of the radius.

The **ulnar artery** (Fig. 18) first runs obliquely downwards and medialwards from its origin at the bifurcation of the brachial, and while resting on the brachialis muscle passes under cover of the pronator teres (both heads), the flexor carpi radialis, palmaris longus, and the flexor digitorum sublimis. It then proceeds vertically downwards to the wrist, lying on the flexor digitorum profundus, and in the interval between the flexor sublimis and the flexor carpi ulnaris. The median

nerve crosses the upper oblique part of the vessel, but is separated from it by the deep head of the pronator teres. The ulnar nerve comes into close relation with the medial side of the artery in the middle third of the forearm, and both structures, lying comparatively superficially in the lower third, cross over the anterior carpal ligament and enter the palm of the hand. Two venæ comites accompany the artery throughout its length.

In the forearm the ulnar artery gives off (1) **muscular** branches of small size at variable points. (2) The **anterior ulnar recurrent**, which will be found in the interval between the brachialis and pronator teres, running upwards anterior to the medial epicondyle of the humerus to join with the anterior branch of the anastomotic artery. (3) The **posterior ulnar recurrent**, larger than the anterior, which is to be followed medially beneath the flexor sublimis, and then upwards between the heads of the flexor carpi ulnaris to the back of the medial epicondyle of the humerus, where it runs in the groove occupied by the ulnar nerve and anastomoses with the ulnar collateral and anastomotic arteries. (4) The **common interosseous** artery is a short trunk arising about one inch below the commencement of the ulnar. It is directed backwards to the interosseous space, where it divides into anterior and posterior branches. The **posterior interosseous** artery passes between the radius and ulna, in the interval between the oblique and interosseous ligaments, to the back of the forearm, where it will be dissected. The **anterior interosseous** artery (Fig. 18) is to be followed down on the front of the interosseous membrane, where it will be found (with the anterior interosseous nerve) between the flexor pollicis longus and flexor digitorum profundus. At the upper border of the pronator quadratus it gives off a small anterior branch which runs in front of that muscle to join the anterior carpal arch; while the larger posterior branch pierces the interosseous membrane behind the pronator quadratus, and passes downwards, on the dorsal aspect of the wrist beneath the extensor tendons to join the posterior carpal arch. The anterior interosseous gives numerous muscular branches; a median branch accompanying the median nerve (sometimes of large size), and a nutrient artery to both the radius and the ulna. (5) The **anterior carpal** artery runs beneath the flexor tendons near the lower border of the pronator quadratus. It anastomoses with the anterior carpal branch from the radial to form the anterior carpal arch. (6) The **posterior carpal** artery passes to the back of the wrist, and will be seen later.

The **ulnar nerve** (Fig. 18) enters the forearm from behind the medial epicondyle (to where it has been traced), by passing between the heads of the flexor carpi ulnaris. It lies under cover of that muscle and upon the flexor digitorum profundus for the whole of its course in the forearm. In the middle third of the forearm it comes into relation with the ulnar artery, and, keeping to its medial side, accompanies it over the anterior carpal ligament into the palm. The ulnar nerve supplies, of all the muscles of the forearm, only the flexor carpi ulnaris and the medial half of the flexor digitorum profundus. In the lower half of the forearm it gives off a **dorsal** cutaneous branch which turns backwards beneath the tendon of the flexor carpi ulnaris to be distributed to the back of the hand and to the ring and little fingers. A **palmar** cutaneous branch, of small size, arises below the middle of the forearm, and after running down in front of the ulnar artery becomes cutaneous close above the anterior carpal ligament, and is distributed to the skin of the palm on the ulnar side. It communicates with the palmar cutaneous branch of the median.

The **median nerve** (Fig. 18) leaves the antecubital fossa by passing

between the heads of the pronator teres, and as it does so crosses the ulnar artery. It continues downwards between the radial and humeral origins of the flexor digitorum sublimis, and then lies between the flexor sublimis and flexor profundus muscles. Near the wrist it is placed superficially, and lies between the tendon of the flexor carpi radialis and the radial side of the flexor sublimis. It passes beneath the anterior carpal ligament into the palm of the hand. It is accompanied by the small median artery. The median nerve supplies all the superficial muscles of the front of the forearm, except the flexor carpi ulnaris, and gives off the **anterior interosseous** nerve (Fig. 18). This branch runs with the artery of the same name and supplies the flexor pollicis longus, the lateral half of the flexor digitorum profundus, and ends on the deep surface of the pronator quadratus which it also supplies.

THE PALM OF THE HAND

(It is practically essential, in order to grasp the intricacies of the muscle and ligament attachments, and to understand the arrangements of the vessels and nerves, that an articulated skeleton of the hand should be beside the dissector throughout this dissection.)

The skin has already been removed from the palm of the hand and it will be remembered that three small palmar cutaneous nerves —from the radial, the median, and the ulnar—were found to be distributed to it. The superficial fascia is now to be removed, and the **palmar fascia** (Fig. 17) cleanly exposed; the central part is strong and thick, but those parts covering the muscles of the thenar and hypothenar eminences are much thinner, and require care for their preservation. On the medial side of the hand a small transverse muscle, the **palmaris brevis**, is to be found in the superficial fascia just below the pisiform bone, and its insertion into the skin is to be preserved. The skin is also to be removed from the front of the thumb and fingers by an anterior medial incision in each.

The **palmar fascia** or **aponeurosis** (Fig. 17) consists of three parts. The central strong part (the aponeurosis proper) is attached above to the anterior carpal ligament, and into it the palmaris longus tendon may now be traced. It expands towards the roots of the fingers, and opposite the heads of the metacarpal bones splits into four slips, each of which is prolonged into one of the fingers and attached to its fibrous tendon sheath. Near the clefts of the fingers, transverse fibres (sometimes called the superficial transverse ligament) will be observed to bind the slips together, and it is here that the palmar digital vessels and nerves become subcutaneous by emerging from below the palmar fascia. It is a point of importance to note that the skin is firmly bound down to this portion of the palmar fascia. The lateral parts of the palmar fascia are very much thinner than the central part, and simply form coverings of the short muscles of the thumb and little finger.

The **palmaris brevis** (Fig. 17) is a small cutaneous muscle which arises from the medial edge of the central palmar fascia. Its fibres run transversely and cross over the ulnar artery and nerve, and are inserted into

the skin on the medial margin of the hand. The muscle is supplied by the ulnar nerve, but in most people it cannot be voluntarily contracted.

The central part of the palmar fascia is to be detached from the anterior carpal ligament and turned downwards towards the fingers. Immediately underneath the fascia, and requiring careful dissection that they be not injured, there will be seen a transversely placed artery, the **superficial palmar arch**, and the **median** and **ulnar nerves** (Fig. 19). The arterial arch will be found to be continuous with the **ulnar artery** (which in addition gives off a **deep** branch disappearing between the muscles of the little finger), and to be completed on the lateral side of the hand by anastomosis with (usually) the **superficial volar** branch of the **radial**. From the arch four **digital** branches are to be traced forwards to the roots of the fingers. The ulnar nerve breaks into **digital** branches for the cutaneous supply of the palmar aspect of the little and ulnar side of the ring fingers, and the median nerve divides to supply the sides of the remaining digits; while from each nerve, soon after it enters the palm, **muscular** branches are given off to the related muscles. The ulnar nerve, in addition, gives off a **deep branch** which accompanies the deep branch of the artery, and supplies the deep muscles of the palm.

The **superficial palmar arch** (Fig. 19) is the direct continuation of the ulnar artery, which is to be traced into the palm over the anterior carpal ligament, where it lies close to the lateral side of the pisiform bone, and is covered by a fibrous slip from the tendon of the flexor carpi ulnaris. In the palm the vessel forms an arch (with the convexity forwards), which lies close beneath the palmar aponeurosis on the flexor digitorum tendons and superficial to the branches of the median and ulnar nerves. The arch is completed on the lateral side by (usually) the superficial volar branch of the radial artery (which generally emerges from the fibres of the abductor pollicis brevis muscle), or by the branches of the radial artery to the thumb or index finger. From the convexity of the arch there are given off four **digital** arteries, the first of which runs to the ulnar side of the little finger, while the others bifurcate at the roots of the fingers to supply their contiguous sides, up to and inclusive of the ulnar side of the index finger. The thumb and the radial side of the index finger are supplied from the radial artery. The digital arteries may be traced along the sides of the fingers. They terminate in a plexus under the nail. They are accompanied by the digital nerves, which, placed deep to the arteries in the palm, assume a position superficial to them in the digits.

The **anterior carpal ligament** (Fig. 19) is to be examined and then to be divided down its centre. It is a broad and strong fibrous band, which is attached on the lateral side to the navicular bone and the trapezium, and on the medial side to the hamulus of the unciform (hamate bone), and to the pisiform bone. It is crossed by the ulnar

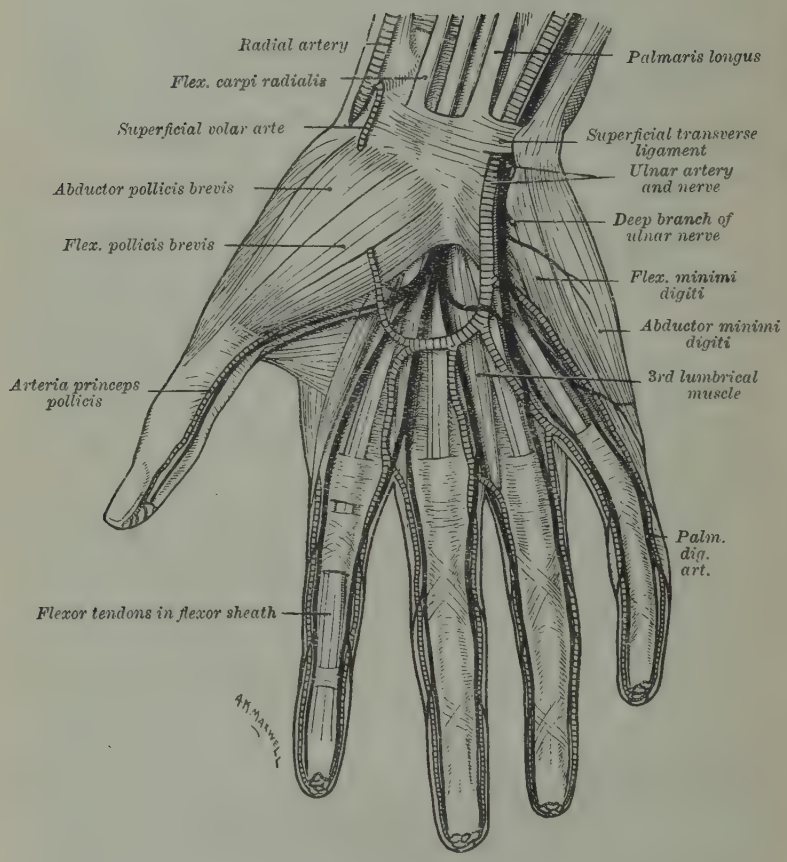


FIG. 19.

Dissection of the palm of the hand.

vessels and nerve, the palmar cutaneous nerves and the tendon of the palmaris longus, some of the deeper fibres of which are inserted into it. The tendon of the flexor carpi ulnaris sends an expansion to it over the ulnar vessels and nerve (Fig. 19), and that of the flexor carpi radialis perforates its lateral attachment, and will afterwards be traced across the trapezium to its insertion on the second metacarpal bone. Beneath the ligament, and passing through the tunnel formed by it and the carpal bones, are the median nerve and

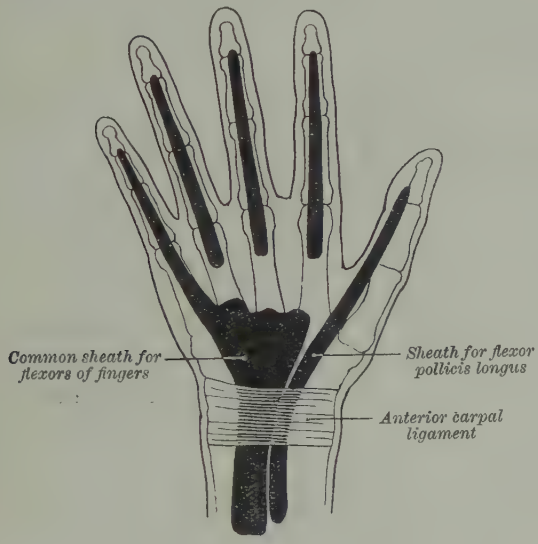


Fig. 20.

The synovial sheaths of the hand.

the tendons of the flexor muscles of the fingers and thumb surrounded by their **synovial sheaths** (Fig. 20). These sheaths, of considerable surgical importance, are two in number; one for the tendon of the flexor pollicis longus, and the other, larger and complex in its arrangement, for the tendons of the superficial and deep flexors of the fingers. They extend from just above the carpal ligament to about the middle of the palm, and they (as a rule) communicate, respectively, with the digital synovial sheaths of the thumb and of the little finger, and sometimes with one another. Four small **lumbricales** muscles (Fig. 19) will be seen attached to the tendons of the flexor profundus in the palm; their nerves should be secured at once, but their insertions cannot be studied till the backs

of the fingers are dissected. The fibrous tendon-sheaths of the remaining fingers, and that of the thumb, which is not very strong, are to be slit open and the disposition and attachment of the flexor tendons are to be re-examined.

The **median nerve** (Fig. 21), which has already been followed to the wrist, passes beneath the carpal ligament superficially to the tendons, and divides, as already described, into the palmar digital cutaneous nerves of the lateral three and a half fingers. The first—the most lateral—branch gives small twigs to each of the muscles of the thenar eminence—the abductor brevis, the opponens, and the superficial head of the flexor

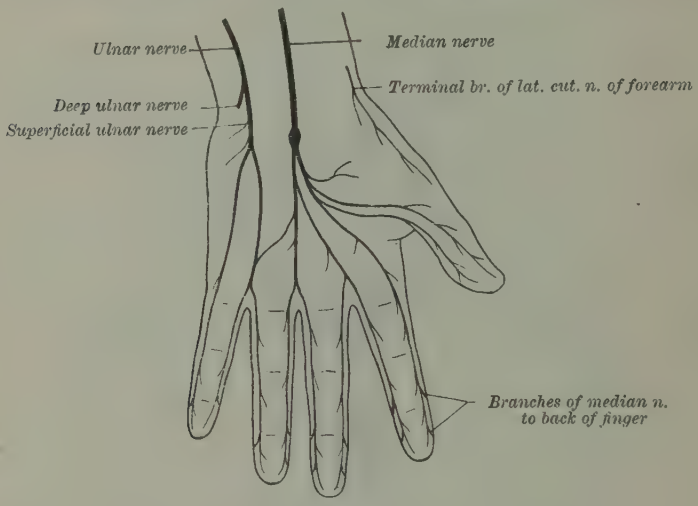

Ulnar nerve
Deep ulnar nerve
Superficial ulnar nerve
Median nerve
Terminal br. of lat. cut. n. of forearm
Branches of median n. to back of finger

FIG. 21.
The distribution of the median and ulnar nerves in the hand.

pollicis brevis, and then bifurcates to supply the two sides of the thumb. The second nerve supplies the first lumbrical muscle, and runs along the radial side of the index finger; the third gives a twig to the second lumbrical, and divides to supply the contiguous sides of the index and middle fingers; and the fourth bifurcates to supply the contiguous sides of the middle and ring fingers, that to the latter finger usually joining with a branch of the ulnar nerve. The digital branches supply not only the palmar aspects and the sides of the fingers, but are also the sole supply of the dorsal aspects of their distal halves.

The **ulnar nerve** (Fig. 21) crosses the anterior carpal ligament lying to the medial side of the ulnar artery, and at once divides into superficial and deep divisions. The superficial branch, having given a twig to the palmaris brevis, breaks into the palmar digital nerves to the medial side of the little finger and adjacent sides of the little and the ring fingers. These branches, like the corresponding branches of the median, also supply the backs of the distal parts of the digits.

The median nerve is to be divided at the wrist, and turned forwards, and the ulnar artery cut beyond the origin of its deep branch, so that the superficial palmar arch may be thrown distally as far as possible. The tendons of the superficial and deep flexors are to be traced to their insertions, and the lumbrical muscles cleaned and their origins defined. The tendons of the deep flexor are then to be divided at the wrist, tied together, and pulled forwards.

The **lumbricales** (Fig. 19) are four small "worm-like" muscles which arise from the tendons of the flexor digitorum profundus in the palm. The first and second lumbricals arise, respectively, from the radial side of the tendons of the index and middle fingers, while the third and fourth are attached to the contiguous sides of the tendons of the middle and ring, and ring and little fingers respectively. The muscles end in slender tendons, which wind round the radial sides of the fingers, and are inserted over the backs of the first phalanges into the extensor tendons. The first and second lumbricals are supplied by the median nerve, but the third and fourth receive twigs from the deep branch of the ulnar.

The intrinsic **muscles** of the **little finger** (which form the hypothenar eminence) are now to be dissected. The **abductor minimi digiti** (Fig. 19) is the most superficial and the most medial of these. It is separated from the **flexor minimi digiti brevis** (Fig. 19) by the deep branches of the ulnar artery and nerve, but both muscles are inserted together on the medial side of the base of the first phalanx. The **opponens minimi digiti** (Fig. 22) lies below these muscles, and is distinguished by being inserted into the whole length of the medial margin of the shaft of the metacarpal bone. These muscles arise close together from the medial end of the anterior carpal ligament and its bony attachments—the hook process of the unciform (hamate) and the pisiform bone. Their nerves are branches of the deep division of the ulnar.

The short **muscles** of the **thumb** (which form the thenar eminence) must next be examined. The **abductor pollicis brevis** (Fig. 19) is the most superficial and most lateral of the series, and is inserted on the lateral side of the base of the first phalanx. Beneath it, and to be seen after its division, is the **opponens pollicis** (Fig. 22), whose fibres are inserted along the lateral margin of the metacarpal bone and thus enable this muscle to be distinguished from the **flexor pollicis brevis** (Fig. 21) lying medial to it, and inserted on the first phalanx with the abductor.[1] These three muscles arise from the

[1] It is usually possible to distinguish a **deep head** of origin of the flexor pollicis brevis, which arises from the trapezoid and os magnum and passes laterally under the tendon of the long flexor to join the more superficial part of the muscle. It is closely associated with the upper margin of the adductor pollicis obliquus.

lateral end of the anterior carpal ligament, and from the navicular and trapezium bones, and lie lateral to the tendon of the flexor pollicis longus. Their nerves are branches of the median. The **adductor pollicis** (Fig. 22) is inserted on the medial side of the base of the first phalanx, and will be seen to consist of two parts—the **obliquus** head arising from the bases of the second and third metacarpal bones, and the **transversus** portion from the distal half of the shaft of the third. Associated with them in insertion, and like them having its nerve supply from the deep branch of the ulnar, there is usually to be found a small muscular bundle arising from the ulnar side of the base of the first metacarpal. It is named, from its position and action, the first **palmar interosseous** muscle.

The muscles occupying the inter-metacarpal spaces are the **palmar** and **dorsal interossei**.

The **deep** branches of the **ulnar artery** and **nerve** are now to be followed. The artery will be found to complete, on the medial side, the **deep palmar arch**, which is the continuation into the palm of the hand of the **radial artery**, as is to be shown by the reflection of the oblique head of the adductor pollicis.

The course and the insertion of the **flexor carpi radialis** across the trapezium and on the second metacarpal bone are now conveniently dissected out.

The **deep** branch of the **ulnar nerve** arises from the ulnar trunk near the pisiform bone, and, with the deep branch of the artery, dips down between the flexor brevis and the abductor minimi digiti, giving branches to both of these muscles and to the opponens. It then passes across the palm, lying beside the deep palmar arch, and supplies the two medial lumbricals, the adductor pollicis and all the interossei muscles.

The **radial artery** (Fig. 22) enters the palm from the dorsum of the hand by passing through the first interosseous (metacarpal) space between the two heads of the first dorsal interosseous muscle. It lies under cover, or amongst the fibres, of the obliquus portion of the adductor pollicis, and emerging between the borders of this and the transversus part of the muscle, passes across the palm as the **deep palmar arch**. The arch has a slight convexity towards the fingers, and lies at a more proximal level in the palm than the superficial arch. It is completed on the medial side by anastomosis with the **deep** branch of the **ulnar artery**.

From the radial artery in the palm there usually arise two branches:—(1) The **arteria princeps pollicis**, which, however, sometimes arises on the back of the hand. It bifurcates to supply both sides of the palmar aspect of the thumb, and may complete the superficial palmar arch. (2) The **arteria radialis indicis** passes forwards under the adductor pollicis obliquus and runs along the radial side of the index finger as its palmar digital vessel. From the arch proper there arise—(1) **recurrent** branches passing backwards to the carpus; (2) three **perforating** arteries, passing to the dorsum of the hand between the heads of the three medial dorsal interossei muscles to anastomose with the dorsal digital arteries; (3) three

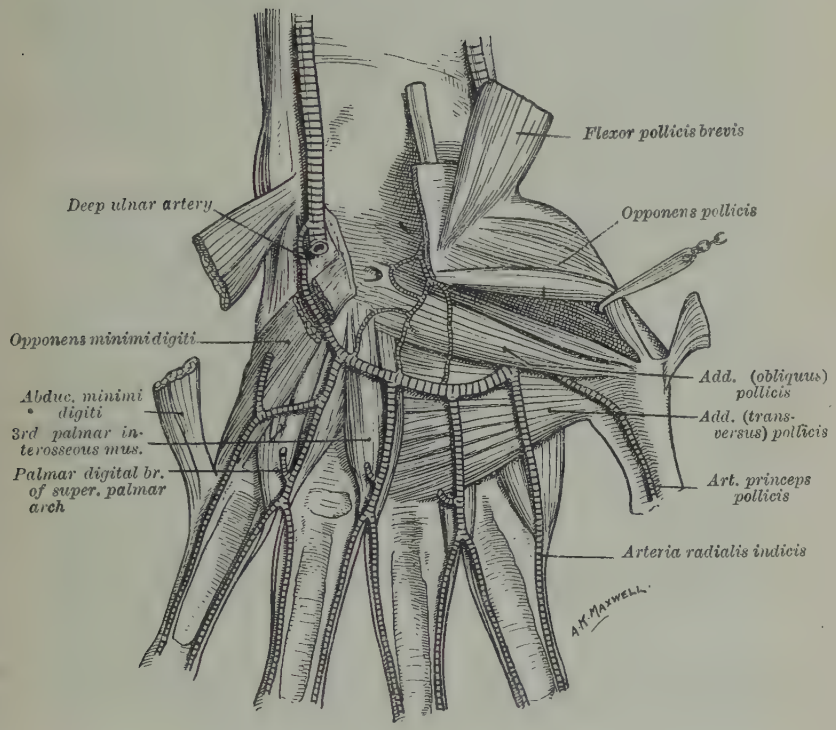


FIG. 22.

Deep dissection of the palm of the hand. (The deep palmar arch.)

palmar interosseous branches running to the roots of the fingers, and there anastomosing with the digital branches of the superficial arch at their points of bifurcation.

The **interossei muscles** are eight in number, four of them being described as **palmar** and four as **dorsal.** The transverse part of the adductor pollicis must be detached from its origin to expose the more lateral of the series, and the palmar muscles may then be cleaned. In front of the heads of the metacarpal bones, and closely connected to the fibrous sheaths of the flexor tendons, there will be seen the **palmar transverse metacarpal** ligament. It must be divided in order to follow out the tendons of the interossei, which pass beneath it.

The four **palmar interossei** muscles are placed in the spaces between the metacarpal bones, and are numbered from the radial side (Fig. 22). They act as flexors of the fingers at the metacarpo-phalangeal joints, and as adductors of the fingers towards a line prolonged through the middle metacarpal bone. They are, therefore, arranged as follows:—The first muscle arises from the ulnar side of the metacarpal bone of the thumb, and is inserted into the ulnar side of the base of the first phalanx of that digit. The second arises from the ulnar side of the metacarpal bone of the index finger, and is inserted into the ulnar side of the base of its first phalanx. The third acts on the ring finger, arising from the radial side of its metacarpal bone and being inserted on the radial side of the base of its first phalanx, and the fourth muscle has corresponding attachments to the bones of the little finger. Each muscle also sends an expansion to the appropriate extensor tendon.

The four **dorsal interossei** muscles are best dissected from behind. Each arises by two heads, being attached to both of the metacarpal bones of the space it occupies. They are inserted on the bases of the first phalanges, and as they act, in addition to their action as flexors at the metacarpo-phalangeal joints, as abductors of the fingers from the line of the middle metacarpal bone, they are attached as follows:—The first on the radial side of the index finger; the second and third into, respectively, the radial and ulnar sides of the middle finger; and the fourth into the ulnar side of the ring finger. Each muscle also gives a slip to the corresponding extensor tendon.

THE BACK OF THE FOREARM AND DORSUM OF HAND

The skin has already been removed from the back of the forearm and the dorsum of the hand, and the cutaneous nerves of these parts have been studied. The skin is now to be removed from the backs of the thumb and fingers, and their dorsal cutaneous nerves are to be dissected out.

The **dorsal digital cutaneous nerves** (Fig. 23) are derived from the radial and from the dorsal branch of the ulnar, both of which nerves have already been secured as they wind from the anterior to the posterior aspect of the forearm. The nerves communicate with one another on the

dorsum of the hand by transverse twigs, and then each nerve breaks into a series of branches which are continued on to the fingers. The radial nerve is distributed to both sides of the thumb, index, and middle fingers, and to the radial side of the ring finger. The ulnar branch supplies the ulnar side of the ring finger, and both sides of the little finger. (This arrangement of the nerves, it should be said, is subject to variation.) It should be noted, however, that the dorsal digital nerves do not reach to the tips of the fingers, but only about half-way along their lengths, the distal portion of the back of each finger being supplied from the palmar digital nerves.

The **superficial veins** on the back of the hand form an irregular plexus,

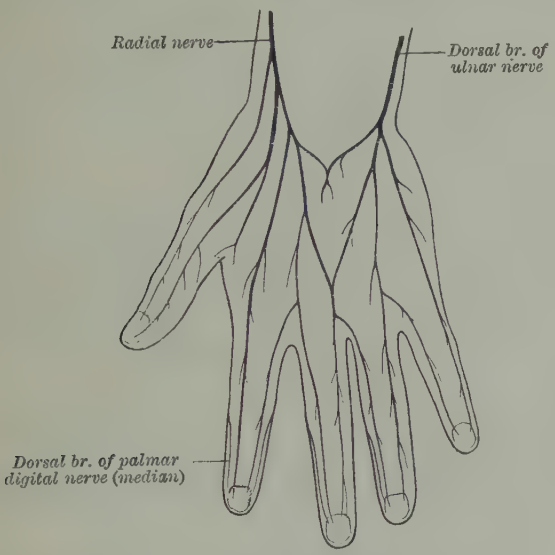


FIG. 23.

The dorsal digital cutaneous nerves.

which, it has been suggested, might be used as evidence of individual identity. From its radial and ulnar extremities ascending trunks arise, and these have already been traced to the cephalic and basilic veins respectively.

The deep fascia of the back of the forearm should now be removed, but it will be found impossible to detach that part near the elbow from the underlying muscles, since it is there incorporated with them. The **posterior carpal ligament**—a thickened band of deep fascia at the wrist, which is attached to the lower ends of the radius and ulna by numerous septa—is to be left in position by artificial definition of its margins.

The **muscles of the back of the forearm** (Figs. 24 and 25) are arranged in two groups, superficial and deep. The superficial group arises from and above the lateral epicondyle of the humerus, and in series, beginning from the radial side, are, the **brachio-radialis, extensor carpi radialis longus, extensor carpi radialis brevis, extensor digitorum communis, extensor minimi digiti, extensor carpi ulnaris,** and, on the medial and upper border of the last muscle, and covered by fascia prolonged from the triceps, the **anconeus.** Two muscles, in close contact with one another, appear superficially at the wrist lateral to the extensor communis, and cross over the radial extensors of the wrist to pass to the back of the thumb. They belong to the deep group of muscles, and are the **abductor pollicis longus** and the **extensor pollicis brevis.** The superficial muscles are now to be examined individually, tracing each downwards under the dorsal carpal ligament and to its insertion.

The **brachio-radialis** (Fig. 17) is placed on the lateral margin of the forearm, and has been seen already in great part in previous dissections. It arises from the upper two-thirds of the lateral supracondylar ridge of the humerus, and from the lateral intermuscular septum of the arm, which separates it from the triceps. It is inserted into the base of the styloid process of the radius. Its tendon is crossed by the two deep tendons of the thumb mentioned above, and the radial nerve passes beneath it to reach the dorsum of the limb. It acts mainly as a flexor of the forearm at the elbow.

The **extensor carpi radialis longus** (Fig. 23) arises from the lower third of the lateral supracondylar ridge and the lateral intermuscular septum. The tendon is crossed by the abductor pollicis longus and the extensor pollicis brevis, and passes under the posterior carpal ligament; and having been crossed by the long extensor of the thumb, is inserted into the base of the metacarpal bone of the index finger.

The **extensor carpi radialis brevis** (Fig. 24) is under cover of, and closely connected with, the preceding muscle. It arises from the common extensor origin—the lateral epicondyle of the humerus—and the fascia of the forearm. Its tendon runs with that of the longus under the posterior carpal ligament, and is crossed over by the thumb tendons as before. It is inserted into the base of the metacarpal bone of the middle finger.

The **extensor digitorum communis** (Fig. 24) arises from the common extensor origin. It ends in four tendons, which pass under the posterior carpal ligament with the tendon of the extensor indicis, and are inserted into the fingers in the following manner. Each tendon receives, on one or both sides, a slip from the tendon of one of the interossei, and then expands upon the proximal phalanx and is joined on the radial side by the tendon of the appropriate lumbricalis. The lateral portions of the expansion are prolonged to the base of the third phalanx, while the middle portion is attached to the base of the second phalanx. (The division of the expansion into three separate slips, sometimes described, is somewhat artificial.) On the back of the hand the tendon of the ring finger is joined by oblique tendinous slips to the tendons on each side of it, and a thin transverse band connects the tendons of the middle and index

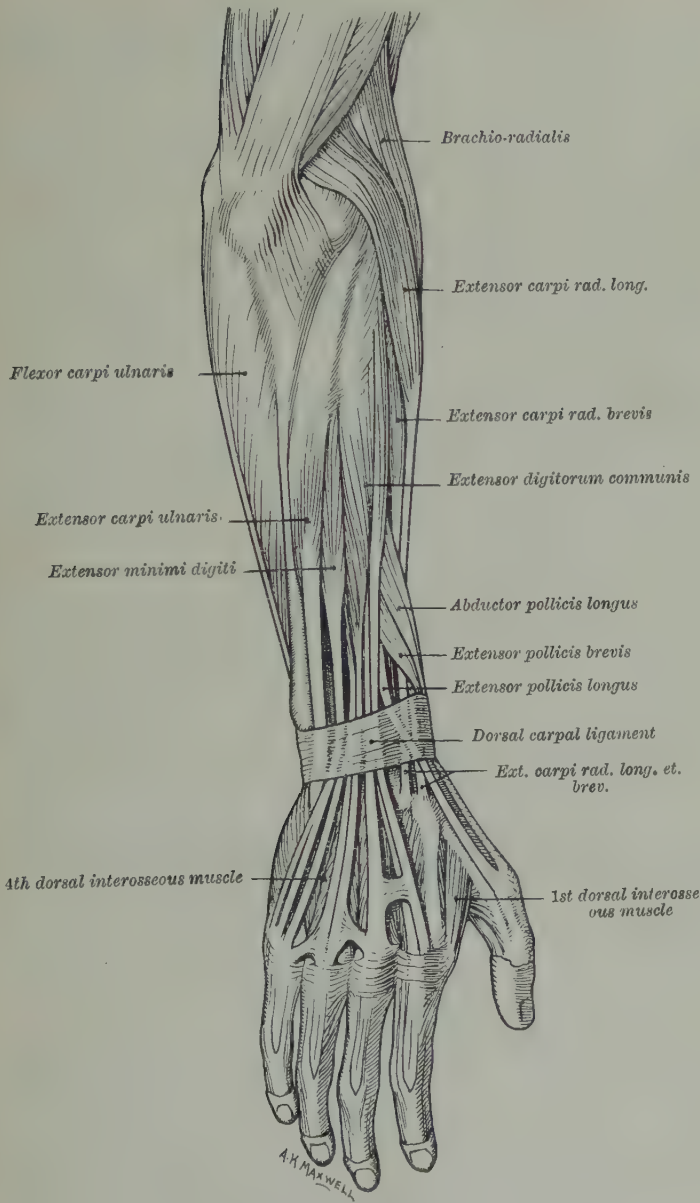


FIG. 24.

The superficial muscles of the back of the forearm.

fingers. The tendon of the little finger is joined by the two divisions of the tendon of the extensor minimi digiti, while the tendon of the extensor indicis joins the ulnar side of the common extensor tendon of that finger on the first phalanx.

The **extensor minimi digiti** (Fig. 24) may appear to be a part of the common extensor, but it is separated from it by an intermuscular septum. It arises from the common extensor origin, and its tendon, after passing under the posterior carpal ligament, is generally divided, both slips being inserted into the expansion of the common tendon on the first phalanx of the little finger.

The **extensor carpi ulnaris** (Fig. 24) arises from the common extensor origin, and has an additional origin from the posterior border of the ulna. The tendon passes over the lower end of the ulna, and under the posterior carpal ligament, to be inserted into the base of the metacarpal bone of the little finger.

The **anconeus** (Fig. 15) is a small triangular muscle at the back of the elbow. It arises from a narrow area on the back of the lateral epicondyle of the humerus and spreads out to be inserted on the lateral surface of the olecranon process and on the upper part of the posterior surface of the ulna. The muscle appears to be continuous with the triceps, but it is to be regarded as belonging to the extensors of the forearm. Its nerve has already been dissected, arising from the musculo-spiral and descending through the medial head of the triceps.

The extensor digitorum communis and extensor minimi digiti are to be divided and reflected downwards. The **posterior interosseous nerve and artery** (Fig. 25) will be exposed, and are to be dissected out, and the branches of the nerve to all the muscles of the back of the forearm, except the brachio-radialis and the extensor carpi radialis longus, have to be traced into their substance. The deep group of muscles will also be brought into view, and are to be cleaned. Four of them emerge from beneath the extensor communis, namely, in series from the lateral side, the **abductor pollicis longus** and the **extensor pollicis brevis** (lying close together), the **extensor pollicis longus** (lying alone), and the **extensor indicis** (closely associated with the extensor communis); and higher up, and embracing the neck of the radius, there is a fifth muscle, the **supinator**, through the fibres of which the posterior interosseous nerve emerges.

The **posterior interosseous nerve** (Fig. 25) is one of the two terminal branches of the musculo-spiral nerve, which has already been seen to divide in the lateral part of the antecubital space under cover of the brachio-radialis. The posterior interosseous branch can now be traced through the fibres of the supinator and round the lateral side of the radius, and having emerged posteriorly, can be followed towards the wrist between the superficial and deep extensor groups. At the upper border of the extensor pollicis longus, it passes on to the interosseous membrane, deep to that muscle, and accompanying the dorsal termination of the posterior branch of the anterior interosseous artery, it may be traced to the back of the wrist, where it ends in a gangliform enlarge-

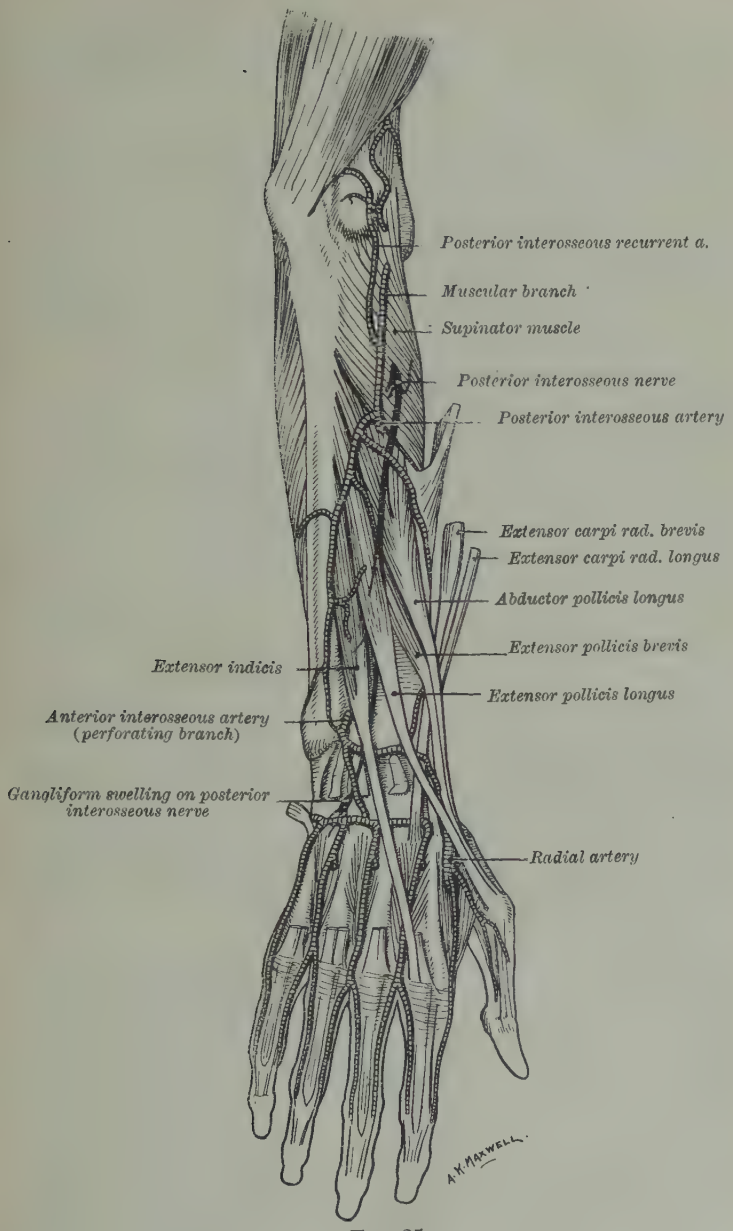


FIG. 25.

Deep dissection of the back of the forearm.

ment under the extensor tendons. It supplies all the muscles on the extensor aspect of the forearm, superficial and deep, with the exception of the anconeus, the brachio-radialis and extensors carpi radialis longus and (frequently) brevis, which are supplied by the musculo-spiral nerve before its terminal division.

The **posterior interosseous artery** (Fig. 25) arises from the common interosseous branch of the ulnar artery, and reaches the back of the forearm by passing between the radius and ulna above the upper edge of the interosseous membrane. It appears between the supinator and the abductor pollicis longus, and giving muscular branches to the extensors and a recurrent branch, is continued downwards between the superficial and deep muscles. It terminates, much reduced in size, by joining the posterior carpal arteries, and the posterior terminal branch of the anterior interosseous artery. The **recurrent** branch runs beneath the anconeus to the lateral and back part of the elbow, where it anastomoses with the posterior branch of the profunda brachii.

The **abductor pollicis longus** (Fig. 25) arises from the middle parts of the posterior surfaces of both the radius and ulna for about two inches, and from the intervening portion of the interosseous membrane. The muscle becomes superficial between the radial extensors of the carpus and the common extensor of the fingers, and crosses the extensors carpi radialis longus and brevis and the insertion of the brachio-radialis. It then passes over the lateral side of the styloid process of the radius under the posterior carpal ligament, and crosses the radial artery. It is inserted into the base of the metacarpal bone of the thumb.

The **extensor pollicis brevis** (Fig. 25) arises from the back of the radius immediately below the abductor pollicis longus, and from the adjacent part of the interosseous membrane. Its tendon lies to the ulnar side of the tendon of the abductor longus in its whole course, and is inserted into the base of the first phalanx of the thumb.

The **extensor pollicis longus** (Fig. 25) arises from the middle of the back of the ulna and from the adjacent part of the interosseous membrane. Its tendon becomes superficial just above the carpal ligament, through which it passes very obliquely, and then crosses the radial extensors of the wrist and the radial artery. It is inserted into the base of the terminal phalanx of the thumb.

The **extensor indicis** (Fig. 25) arises from the posterior surface of the ulna below the preceding muscle and slightly from the interosseous membrane. Its tendon is covered by those of the common extensors, and running beneath the posterior carpal ligament with them, joins the ulnar side of the tendon of that muscle to the forefinger.

The **supinator** (Fig. 25) arises from the triangular area below the lesser sigmoid cavity of the ulna, from the radial collateral ligament of the elbow joint, and from the orbicular ligament of the radius. Its fasciculi sweep spirally round the radius, covering its upper part posteriorly and laterally, and are inserted into the front of the upper third of that bone extending to the medial margin of the neck. It was seen to form the lateral part of the floor of the antecubital fossa, and from there it is pierced by the posterior interosseous nerve, which supplies it. The posterior interosseous artery passes between it and the abductor longus pollicis. It is a powerful supinator of the radius on the ulna.

The arterial anastomoses at the elbow joint, between the branches of the brachial artery from above and the branches of the arteries of the forearm from below, should now be reviewed. The main

anastomosis is posterior. Behind the lateral epicondyle the posterior interosseous recurrent joins the posterior branch of the profunda brachii, and behind the medial epicondyle the posterior ulnar recurrent ascends to join the ulnar collateral and the posterior branch of the anastomotic artery. These posterior anastomoses are connected over the olecranon by a network of transverse vessels. In front of the epicondyles an anastomosis also takes place, laterally between the radial recurrent and anterior branch of the profunda, and on the medial side between the anterior ulnar recurrent and the anterior branch of the anastomotic. By means of these inosculations a "collateral" circulation may be established between the brachial artery and the arteries of the forearm, should it be necessary to ligature the former vessel in its lower part.

The **radial artery** (Fig. 25) is to be followed from the front of the lower end of the radius and traced backwards below the styloid process. It lies against the lateral ligament of the wrist-joint, and beneath the abductor longus and extensor pollicis brevis, and then winds over the back of the carpus to the interval between the metacarpal bones of the thumb and forefinger, where it is crossed by the extensor pollicis longus. Finally, it passes into the palm of the hand between the two heads of the first dorsal interosseous muscle. It is accompanied here as elsewhere by venæ comites.

The **branches** of the radial artery (Fig. 25) in this dorsal part of its course are small and vary considerably. (1) The **posterior carpal artery** runs transversely beneath the extensor tendons, and joining the posterior carpal branch of the ulnar, forms the posterior carpal arch. From this arch two dorsal interosseous branches run towards the fingers in the third and fourth inter-metacarpal spaces. The corresponding artery in the second inter-metacarpal space arises, as a rule, directly from the radial. These vessels bifurcate at the web of the fingers to form the dorsal digital arteries. (2) In the first inter-metacarpal space two vessels usually arise separate from the radial artery just before it passes through the first dorsal interosseous muscle, the **dorsalis indicis** which runs on the lateral side of the index finger, and the **dorsalis pollicis** which goes to the thumb, and generally divides into two twigs, one on each side of that digit.

The **posterior carpal ligament** (Fig. 24) is a thickened band of the deep fascia of the forearm, stretching obliquely across the back of the wrist. It is fixed to the lateral margin of the lower end of the radius, and on the medial side to the cuneiform and pisiform bones. From its deep surface septa pass to be attached to the back of the radius and ulna, and form, with the ligament and the carpus, a series of six compartments in which the extensor tendons are contained. The compartments should now be opened up, and each, with the contained tendons, will be found lined with synovial membrane. The first compartment is on the lateral side of the

lower end of the radius, and contains the abductor pollicis longus and the extensor pollicis brevis. The second compartment corresponds with the most lateral groove on the back of the radius, and contains the tendons of the extensors carpi radialis longus and brevis. The third compartment is over the narrow oblique middle groove on the back of the radius, and passing through it is the extensor pollicis longus. The fourth compartment corresponds to the medial broad groove on the back of the radius, and transmits the tendons of the extensor digitorum communis and extensor indicis. The fifth compartment is over the interval between the radius and the ulna, and transmits the extensor minimi digiti. The sixth compartment corresponds to the groove on the dorsum of the ulna, and transmits the tendon of the extensor carpi ulnaris.

(While examining these compartments, the student should have beside him for reference the dried bones.)

The **dorsal interossei** muscles should now be examined, and the anastomosis between the palmar and dorsal interosseous arteries can be displayed.

THE ELBOW JOINT

The muscles about the elbow are to be removed, care being taken, especially in detaching the supinator, not to damage the underlying capsular ligaments. Beneath the triceps a small slip of muscle, the **subanconeus**, may be found passing from the lower end of the humerus to the posterior part of the capsule; often, however, it is entirely wanting.

At the elbow there are two joints, concerned in entirely different movements, but continuous with one another, possessing a common synovial membrane, and enclosed in the one fibrous capsule; namely, that between the humerus and the bones of the forearm—the elbow joint proper, and that between the upper ends of the radius and ulna—the superior radio-ulnar articulation. The **collateral** ligaments of the elbow joint (Figs. 26 (*a*) and 26 (*b*)), well marked thickened bands, should be defined first, and then the **orbicular** ligament (Fig. 26 (*b*)) of the radio-ulnar joint. The anterior and posterior parts of the capsule are thin, and stretch from above the fossæ at the lower end of the humerus to the bones of the forearm below. They are to be removed so as to expose the interior of the joint.

The **ulnar collateral ligament** is attached above to the lower part of the medial epicondyle of the humerus, and below spreads along the medial margins of the olecranon and coronoid processes of the ulna. The **radial**

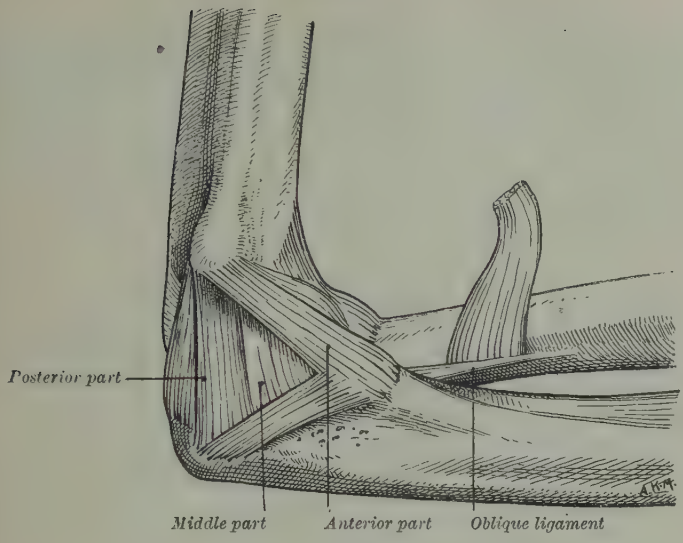


FIG. 26 (*a*).

The elbow joint from the medial side. After Quain.
(The ulnar collateral ligament.)

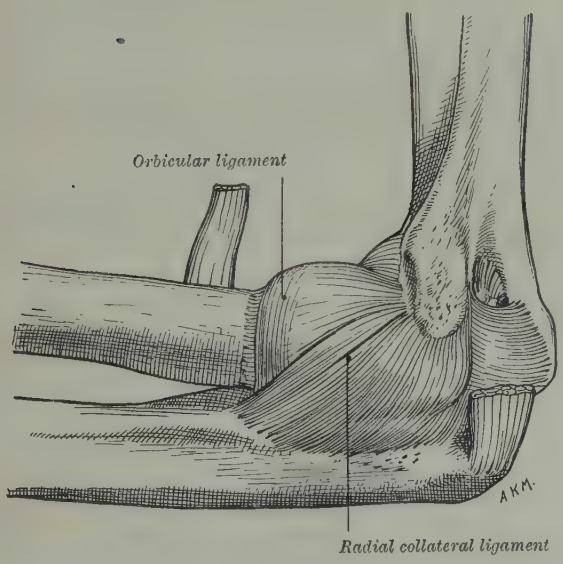


FIG. 26 (*b*).

The elbow joint from the lateral side. After Quain.

collateral ligament is fixed above to the lower part of the lateral epicondyle and below is attached to the orbicular ligament and to the margins of the lesser sigmoid cavity of the ulna. The **orbicular** ligament is a strong flattened band binding the radius to the ulna. Its fibres encircle the head and neck of the radius, having but a slight attachment to the neck below, and are fixed by their extremities to the margins of the lesser sigmoid cavity of the ulna. In connection with the **synovial membrane** synovial pads of fat, "plicæ adiposæ," will be found related to the olecranon, coronoid, and radial fossæ of the humerus.

THE RADIO-ULNAR ARTICULATIONS

The **superior** articulation is common with the elbow joint. The deep muscles of the forearm are now to be removed so as to expose the **interosseus membrane** between the shafts of the radius and ulna. It is attached to the interosseous borders of both bones, its fibres for the most part running obliquely downwards from the radius to the ulna. Over its upper border, between it and the **oblique ligament**, the posterior interosseous artery passes to the back of the forearm, and the anterior interosseous vessel pierces it near the wrist.

The **oblique ligament** runs from below the lesser sigmoid cavity of the ulna obliquely downwards to the radius below the bicipital tuberosity, the direction of its fibres thus being opposite to those of the interosseous membrane. It is very variable in its development.

All the muscles in the region of the wrist have now to be removed, and the **inferior radio-ulnar** articulation is to be examined. The bones are connected here by anterior and posterior ligaments, short bands which pass between the margins of the sigmoid cavity of the radius and the head of the ulna. The joint is to be opened from the front and back, so as to show the entity of its synovial membrane, and to expose from above the **triangular fibro-cartilage** which intervenes between it and the wrist joint.

THE WRIST JOINT

The joints at the "wrist" may be arranged in three groups: (1) The **radio-carpal** joint, between the under surface of the radius and the upper surfaces of the lateral three of the first row of carpal bones, and to which the triangular fibro-cartilage belongs. (2) The **carpal** joints, the whole of the articulations between the carpal bones themselves. (3) The **carpo-metacarpal** joints, between the distal row of carpal bones and the bases of the metacarpals.

The radio-carpal joint has in front (Fig. 27), and behind, broad but weak bands, attached above to the lower end of the radius,

and below to the first row of carpal bones, and blending there with the ligaments of the carpus. At the sides there are much stronger **collateral** ligaments, the lateral passing from the styloid process of the radius to the navicular and trapezium bones, and the medial

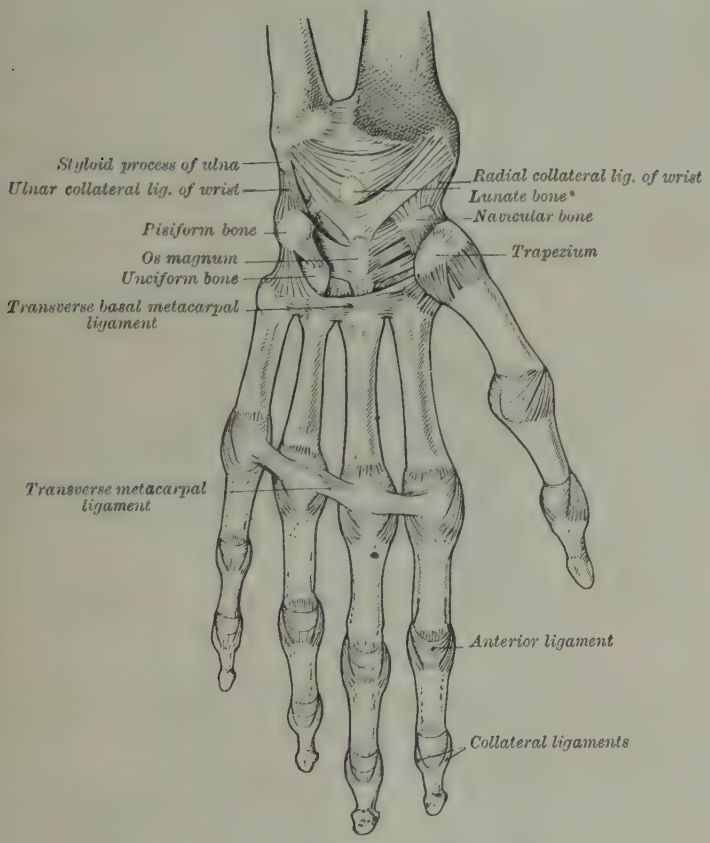


FIG. 27.

The ligaments of the wrist and finger joints (from the front). After Quain.

from the styloid process of the ulna to the cuneiform and pisiform bones.

The ligaments of the carpal and carpo-metacarpal joints are necessarily numerous, but they scarcely repay individual dissection. They may be classified as anterior or palmar, posterior or dorsal,

and interosseous, which connect each bone with its neighbours, and are to be displayed by opening up the joints.

Three transverse incisions are to be made on the dorsal aspect of the wrist—one between the lower end of the radius and the carpus, another between the two rows of carpal bones, and a third between the carpus and metacarpal bones. By this means the position and extent of the **synovial membranes** of the wrist will be determined, and the triangular fibro-cartilage will be fully exposed.

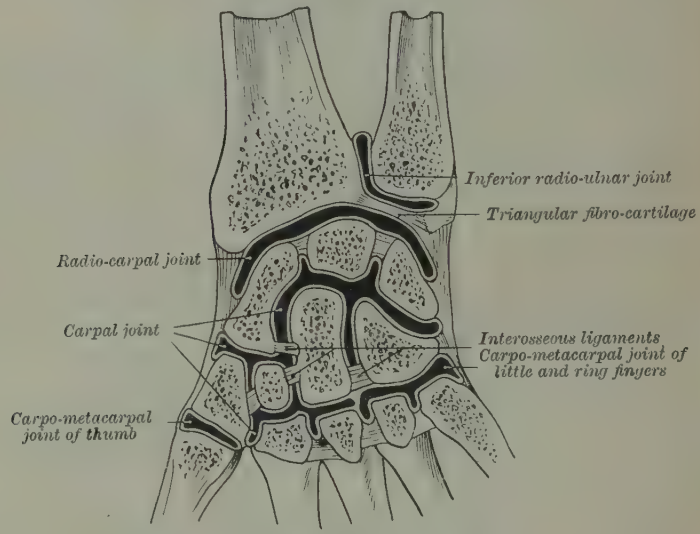


FIG. 28.

The synovial membranes of the wrist. (The joint between the pisiform and cuneiform bones is not shown.)

The **synovial membranes** of the wrist (Fig. 28) are five in number, each indicating a separate joint cavity. (1) That of the radio-carpal joint, between the under surfaces of the radius and the triangular fibro-cartilage above, and the three lateral of the first row of the carpal bones below. (2) That of the carpal joints, between the two rows of carpal bones, and between the several bones themselves, and extending between the second and third metacarpal bones and the opposed carpal surfaces. (3) That lining the small but distinct joint between the pisiform and cuneiform bones. (4) That between the unciform and the two medial metacarpal bones. (5) That of the carpo-metacarpal joint of the thumb.

The **triangular fibro-cartilage** (Fig. 28) is attached by its base along the medial margin of the radius between its ulnar and carpal surfaces, and by its apex to the root of the styloid process of the ulna. The lower surface of the ulna rests on it above, and below, it is in relation with the cuneiform and a small part of the semilunar bone.

THE METACARPO-PHALANGEAL JOINTS

Each of these joints (Fig. 28) is surrounded by its own fibrous capsule and provided with its own synovial membrane. The chief ligaments are the two collateral bands, which are attached to the sides of the head of the metacarpal bone and spread out on the phalanx below. The posterior ligament of the joint is weak, but the anterior is of considerable strength, and passes from above the head of the metacarpal bone to the front of the phalanx, and is tightly stretched in full extension of the joint. The distal ends of the four medial metacarpal bones are joined by the transverse metacarpal ligaments and by weaker dorsal transverse bands ; between these the tendons of the interossei muscles have already been seen to pass. In the anterior ligament of the thumb joint there are two sesamoid bones, which are related to the muscles inserted on the sides of the base of the first phalanx.

THE PHALANGEAL JOINTS

The capsules of these joints (Fig. 28) are strengthened laterally as the collateral ligaments, and in front a fairly definite band can also be defined. Posteriorly, however, the capsule is weak, and in close connection with it is the extensor tendon.

THE LOWER LIMB

(*The Introduction should be read, or re-read, before the dissection is commenced.*)

The order of dissection recommended for the lower limb is detailed below, and indicated in brackets is the number of days[1] students should allot to each region.

1. The body is placed in the lithotomy position: no dissection is carried out (3).

2. The body is placed face downwards: dissection of the **gluteal region** (6).

3. The body is placed on its back: superficial dissection of **front** and **medial side** of **thigh**: deep dissection of **front** of **thigh** (8).

4. Deep dissection of **medial side** of **thigh**: **hip joint**: removal of limb from trunk (4).

5. Dissection of **popliteal space**: **back of thigh** (5).

6. Dissection of **front** of **leg** and **peroneal region**: **dorsum** of **foot** (5).

7. Dissection of **back** of **leg** (5).

8. Dissection of **sole** of **foot** (5).

9. Dissection of **knee** and **ankle joints**: **joints** of **foot** (4).

[1] Saturdays and Sundays are excepted.

THE GLUTEAL REGION

The body being turned on its face, the buttocks are to be raised by blocks beneath the pelvis until the thigh is well flexed with the knee on the table.

Surface Anatomy.—The dissector should recognise the **crest of the iliac bone**, which will bound his dissection superiorly, and trace it anteriorly and posteriorly to its terminations, the **anterior** and **posterior superior spines**; also the **sacrum** and the **coccyx**, and the **tuberosity** of the **ischium**. The tuberosity of the ischium is felt through the **gluteus maximus** muscle in the extended position of the limb, but without the covering of this muscle when the thigh is semi-flexed. The relations of the **great trochanter** of the **femur** to the several parts of the pelvis are of great importance in the diagnosis of fractures and dislocations in this region, and it should be determined that its upper border is situated practically midway on the line (**Nelaton's line**) between the ischial tuberosity and the anterior superior iliac spine. The eminence of the **buttock** (or the **nates**) is formed by the **gluteus maximus** muscle covered by a thick layer of fat, and limited below by a transverse groove—the "fold of the buttock" or the "gluteal sulcus"—which varies in depth according to the amount of fat and the muscular development of the subject. It should be noticed that this groove does not coincide in position or direction with the oblique lower border of the gluteus maximus muscle, but when the limb is extended runs almost horizontally and crosses the lower edge of the muscle near its middle.

An incision is to be made along the iliac crest, and another down the middle of the sacrum to the coccyx, care being taken in both cases only to cut through the skin; and as the perinæum has been dissected, it will only be necessary to make another cut across the upper part of the back of the thigh following obliquely downwards and laterally the lower margin of the gluteus maximus, part of which is already exposed. The flap of skin thus marked out is to be reflected lateralwards. The amount of fat in the **superficial fascia** of the buttock varies considerably in different subjects, and if there is a large quantity it may be difficult to discover the **cutaneous nerves**; in this case the fascia should be removed in one piece from the median line lateralwards, and the trunks of the nerves secured at their exit from the deep fascia. Accompanying the various nerves are small vessels—arteries and veins—which will assist the student in the localisation of the nerves.

The **cutaneous nerves** of the buttock (Figs. 29 and 30) are descending, transverse, and ascending in direction. The **descending** branches will be found crossing over the crest of the iliac bone, and may be arranged in two groups. (1) The lateral branches of the posterior divisions of the upper three lumbar nerves, which pierce the aponeurosis of the latissimus dorsi at the lateral border of the erector spinæ muscle, and running in different planes in the superficial fascia, supply cutaneous branches over

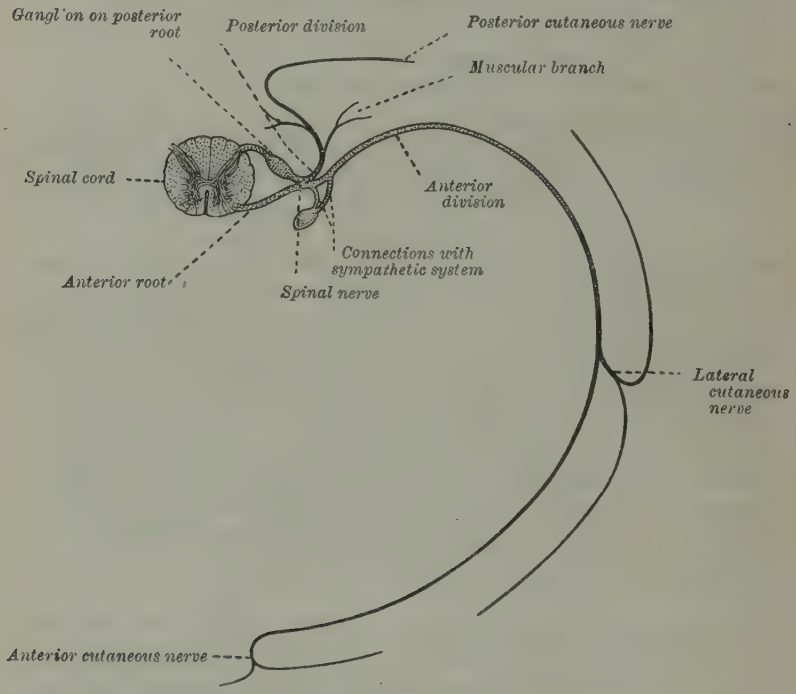


FIG. 29.

Diagram of the formation and distribution of a typical (upper thoracic) *spinal nerve.* A spinal nerve is formed by the junction of its anterior and posterior roots. It has but a short course, and divides into anterior and posterior divisions.

the gluteus maximus. (2) The iliac (lateral cutaneous) branches of the last thoracic and ilio-hypogastric nerves (derived from the anterior divisions of the spinal nerves) cross the iliac crest about two inches from the anterior spine, the former being in front of the latter.

The **transverse** branches appear through the gluteus maximus by the side of the lower part of the sacrum, and are two or three small twigs derived from the lateral branches of the posterior divisions of the upper three sacral nerves.

The **ascending** branches are derived from the small sciatic nerve and the perforating cutaneous branch of the sacral plexus, and turn round the

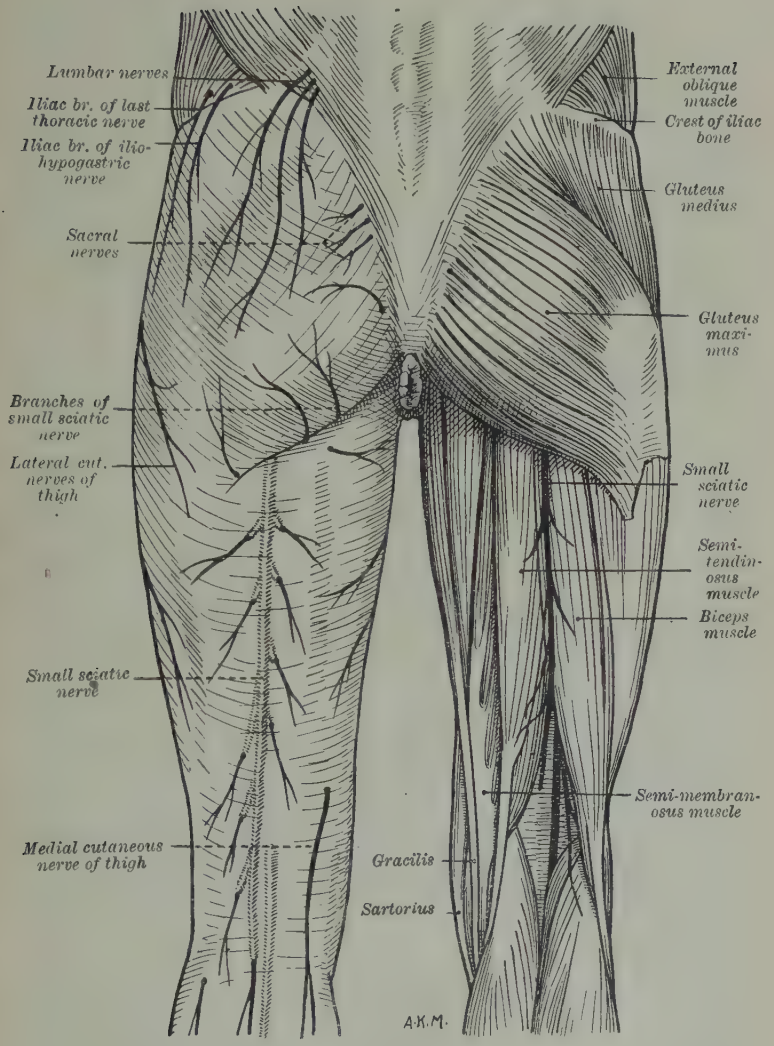


FIG. 30.

The cutaneous nerves and the superficial muscles of the gluteal region and back of the thigh.

lower border of the gluteus maximus to supply the skin over the lower part of the buttock. The former nerves will be found lateral to the tuberosity of the ischium, and in seeking them care should be taken not to injure the main trunk; the latter nerve lies medial to the tuberosity.

The remains of the superficial fascia have now to be removed, and that portion of deep fascia covering the **gluteus medius**, and seen above and in front of the gluteus maximus, is to be cleaned and then the gluteus maximus itself, the fibres of the muscle being put on the stretch by flexing and inverting the thigh. The dissector begins at the upper border of the muscle on the right, and at its lower border on the left limb, and it is essential that the lower border should be thoroughly dissected out in its whole extent. The deep fascia over the fleshy part of the gluteus maximus is thin, but at the insertion of the muscle and over the gluteus medius it is dense and aponeurotic. It is continuous below with the **fascia lata** of the thigh, the upper part of which gives insertion to the greater part of the gluteus maximus muscle, and is therefore on no account to be removed. The **small sciatic nerve** (the posterior cutaneous nerve of the thigh), if not already found, should be secured at this stage under the centre point of the lower border of the gluteus maximus muscle. In cleaning the muscle, the dissector should demonstrate for himself that the fascia covering the gluteus medius splits at the anterior border of the gluteus maximus so as to enclose it.

The **gluteus maximus** (Fig. 30) arises from the small rough area on the dorsum of the iliac bone between the posterior third of the crest and the posterior gluteal line; from the dorsum of the lower part of the sacrum, and the side of the first three pieces of the coccyx; and by deep fibres from the posterior surface of the sacro-tuberous ligament, which will be seen when the muscle is divided. The fibres run downwards and lateralwards. The upper half of the muscle is inserted into the fascia lata (ilio-tibial band); the superficial part of the lower half is also attached to the fascia, but its deeper part is fixed to the rough "gluteal ridge" on the femur leading from the back of the great trochanter to the linea aspera.

The gluteus maximus is to be divided near its origin and turned downwards. Commence by freeing both borders of the muscle, and then raise the whole mass by passing the hand below it. Cut through the attachments to the ilium, sacrum, and coccyx, and then, working laterally, lay bare the surface of the sacro-tuberous ligament. Passing into the deep surface of the muscle, the **inferior gluteal** nerve and branches of the **gluteal** and **sciatic** arteries (the former above the latter) will be seen. They should be traced into the muscle substance, and then, leaving a small portion of muscle

attached to each, divided to allow of the complete reflection of the muscle towards its insertion, the bony part of which is to be defined.

Three **bursæ** will be found under the insertion of the gluteus maximus—one between the upper part of its tendon and the great trochanter; a second between the tendon at its bony insertion and the vastus lateralis muscle of the thigh; and a third over the tuberosity of the ischium. The last is covered by the muscle while the limb is extended, but when flexed the bursa is covered only by skin and fascia. It is liable to inflammatory disturbance, and its extent and relations should therefore be specially studied.

The parts beneath the gluteus maximus (Fig. 31) are now to be displayed. They are covered by loose cellular tissue, which is to be removed and the structures cleaned as far as possible at once, the thigh being rotated medially in order to put the muscles on the stretch. The several structures to be exposed, in order from above downwards, are:—

The **gluteus medius**, overlaid with strong fascia and covering the greater part of the dorsum of the iliac bone.

The **pyriformis** muscle, issuing from the pelvis through the great sciatic foramen.

Between these muscles the **superficial** branches of the **gluteal** vessels, which entered the gluteus maximus muscle.

Issuing from the pelvis below the lower border of the pyriformis, and running downwards over the muscles below it, the **sciatic** vessels and the **great sciatic** and **small sciatic** nerves, and the **inferior gluteal** nerve entering the deep surface of the gluteus maximus muscle.

The tendon of the **obturator internus** emerging through the lesser sciatic foramen, with the **gemelli** muscles, **superior** and **inferior**, above and below it.

The **quadratus femoris** muscle, and deeply between it and the gemellus inferior, the tendon of the **obturator externus**.

The upper border of the **adductor magnus** muscle of the thigh.

The **sacro-tuberous** ligament and the tuberosity of the ischium with the hamstring muscles—**semi-membranosus**, **semi-tendinosus**, and **biceps femoris**—attached to it are readily identified, and then, more laterally, the upper end of the femur covered by the **vastus lateralis**.

Beneath the sacro-tuberous ligament, the **ischial spine** and the **sacro-spinous** ligament extending medialwards from it are to be defined, and crossing over them the **internal pudendal** (pudic) **vessels** and **nerve** are to be secured. Lateral to the pudendal vessels, and

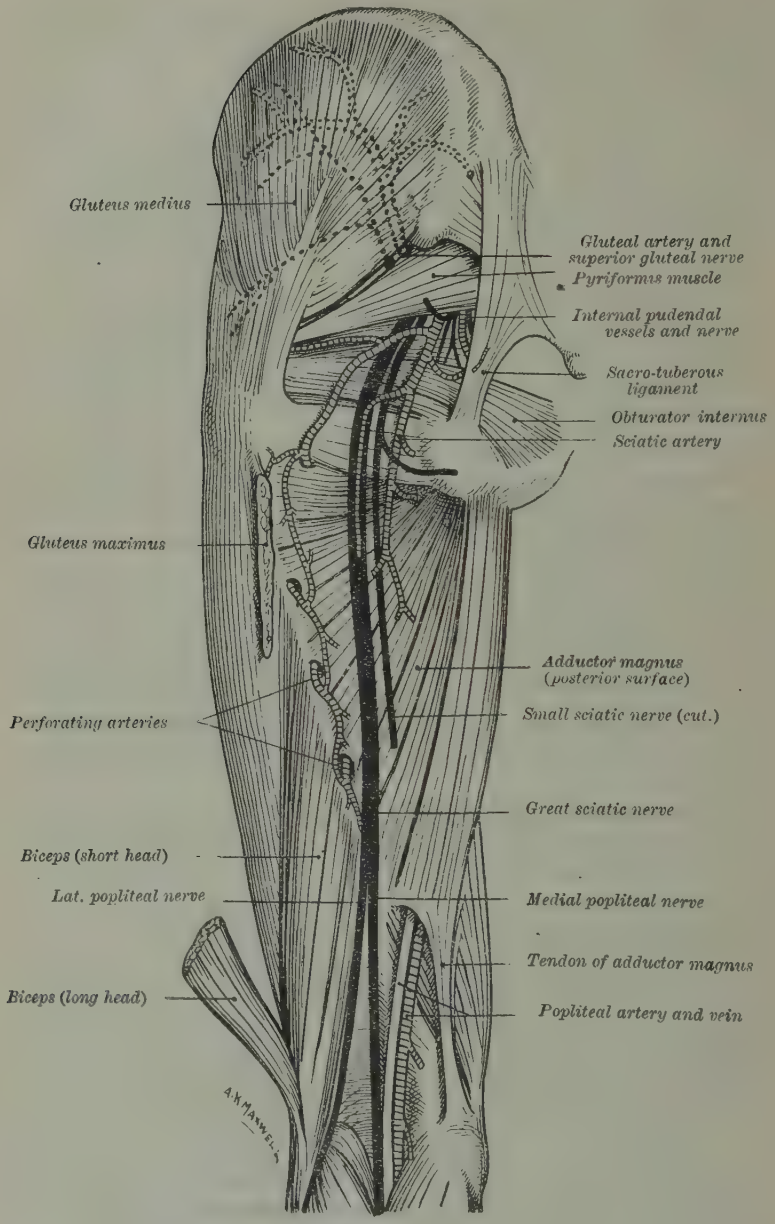


FIG. 31.

Deep dissection of the gluteal region and back of the thigh.

also crossing the spine of the ischium, the small **nerve** to the **obturator internus** should be sought, and yet more laterally and running under the gemellus superior, the **nerve** to the **quadratus femoris.**

Lastly the terminal branches of the **medial circumflex femoral** artery should be secured at the upper and lower borders of the quadratus femoris.

After he has identified these structures, and become informed regarding their relative positions, the student should complete the study of the different muscles.

The **gluteus medius** (Fig. 30) arises from the area on the dorsum of the iliac bone bounded by the anterior and posterior gluteal lines and the anterior four-fifths of the iliac crest; and from the fascia lata covering it above the gluteus maximus. The fibres converge to be inserted into the diagonal line on the lateral surface of the great trochanter, extending from its posterior superior angle obliquely downwards and forwards. The anterior border of the gluteus medius is frequently united with that of the **gluteus minimus**—which lies beneath it—so that accurate definition of those borders is not easily accomplished from the back. The insertion of the gluteus medius is best seen when the muscle has been divided. A bursa will be found under its tendon, separating it from the surface of the great trochanter above the diagonal line.

The gluteus medius is to be divided close to its origin and detached from the bone with the handle of the knife—without injuring the gluteus minimus—the separation between the muscles being indicated by the deep branches of the **gluteal vessels.** The anterior borders of the muscles having been separated with a scalpel, the gluteus medius is to be turned down to its insertion, and the branches of the gluteal vessels and of the **superior gluteal** nerve are to be traced into its substance and then divided.

The **gluteus minimus** (Fig. 31) arises from the area on the dorsum of the iliac bone bounded by the anterior and inferior gluteal lines; from the upper part of the anterior margin of the great sciatic notch, and from the anterior border of the ilium as far as the anterior inferior spine. It is inserted into the anterior border of the great trochanter, and its tendon is closely adherent to the capsule of the hip joint.

The **pyriformis** (Fig. 31) arises within the pelvis from the front of the lateral mass of the sacrum between the first and fourth sacral foramina; also from the upper part of the great sciatic notch, and often from the sacro-tuberous ligament. The muscle passes out of the pelvis through the great sciatic foramen and ends in a round tendon, which crosses the tendon of the obturator internus and gemelli, and is adherent to them and to the capsule of the hip joint. It is inserted into a depression at the posterior part of the upper margin of the great trochanter. The muscle is occasionally divided into two parts by the passage of a portion of the sciatic nerve through its fibres. It is supplied within the pelvis by special branches of the sacral plexus.

The **obturator internus** and **gemelli** (Fig. 31).—It is only the tendon

of the obturator internus which can be seen at present, the muscle arising on the inner surface of the hip bone round the anterior two-thirds of the obturator foramen and from the corresponding portion of the inner surface of the obturator membrane. The tendon makes its exit through the lesser sciatic foramen, and being joined by the gemelli, passes forwards and laterally beneath the tendon of the pyriformis (with which it is more or less united), to be inserted in front of it into a depression at the anterior part of the upper margin of the great trochanter. The **gemelli** (twin muscles) are placed above and below the tendon of the obturator internus, and are inserted into its margins and deep surface. One or both may be absent. The **superior** muscle arises from the spine of the ischium and the adjacent portion of the lesser sciatic notch, while the **inferior** arises from the upper part of the tuberosity of the ischium, and is the larger and more constant muscle.

The **quadratus femoris** (Fig. 31), so named from its quadrilateral shape, arises from the tuberosity of the ischium lateral to the hamstring muscles. Its fibres pass horizontally lateralwards to be inserted on a vertical line on the back of the femur below the middle of the posterior inter-trochanteric line. It lies immediately above the **adductor magnus**, with which it is sometimes continuous.

The tendon of the **obturator externus** will be found lying deeply between the inferior gemellus and the quadratus muscles. The origin of the muscle will be seen later, but the tendon should be observed to wind round the neck of the femur from below, and to pass laterally to be inserted into the digital fossa at the root of the great trochanter.

Having examined the muscles of this region, and appreciated their relative positions, the student should now secure and follow out the various vessels and nerves. He will observe that all make their exit from the pelvis through the great sciatic foramen, and that they may be divided into two groups—those issuing above, and those issuing below, the pyriformis muscle. Commence with the former group, the **gluteal artery** and the **superior gluteal nerve**.

The **gluteal artery** (Fig. 31) is a branch of the internal iliac artery, and emerges from the pelvis through the great sciatic foramen. It appears at the lower border of the gluteus minimus, and breaks into superficial and deep divisions. The superficial division is distributed to the under surface of the gluteus maximus, and its branches were divided in the reflection of that muscle. The deep division subdivides into superior and inferior branches, both of which lie between the gluteus medius and minimus muscles, and are accompanied by branches of the superior gluteal nerve. The superior branch runs along the anterior gluteal line, and ends at the anterior border of the ilium by anastomosing with the superficial and deep circumflex iliac arteries. The inferior branch crosses the gluteus minimus and runs towards the great trochanter. It anastomoses with the lateral femoral circumflex and the sciatic arteries.

Venæ comites accompany the branches of the artery, and pass into the pelvis to open into the internal iliac vein.

The **superior gluteal nerve** (Fig. 31) is a branch of the sacral plexus, and emerges from the pelvis with the gluteal artery above the pyriformis.

It divides into two branches, which accompany the deep division of the artery between the gluteus medius and minimus and supply these muscles ; and the lower branch passes forwards, and, as will be seen from the front, terminates in the tensor fasciæ latæ muscle.

Turning to the vessels and nerves which emerge below the pyriformis, the student should in the first place examine the **sciatic artery** and the **inferior gluteal** and the **great** and **small sciatic nerves.**

The **sciatic artery** (or inferior gluteal) (Fig. 31) is a branch of the internal iliac artery, and emerges from the pelvis through the great sciatic foramen below the pyriformis (where its position is indicated on the surface by a point at the junction of the middle and lower thirds of a line running from the posterior superior iliac spine to the ischial tuberosity). It gives large branches to the gluteus maximus, and muscular branches to the other smaller muscles of the neighbourhood which accompany their respective nerves ; and anastomoses with both the lateral and medial circumflex and the first perforating branches of the profunda femoris artery. Its named branches are : (1) the **coccygeal**, which pierces the sacro-tuberous ligament to supply the parts about the coccyx ; (2) the **comes nervi ischiadici**, a minute artery which runs upon the great sciatic nerve and into its terminal branches, and appears to be the direct continuation of the main trunk ; (3) the **anastomotic** branch, which passes towards the great trochanter to anastomose with the gluteal and medial femoral circumflex arteries in the so-called "crucial anastomosis."

The veins corresponding to the sciatic artery open into the internal iliac vein, and have the same course as the artery.

The **inferior gluteal nerve** (Fig. 31) arises from the sacral plexus, and is usually connected with the small sciatic nerve. It enters the gluteal region through the lower part of the great sciatic foramen and enters the deep surface of the gluteus maximus in numerous small twigs, which were cut in the reflection of the muscles.

The **small sciatic** nerve (Fig. 31) is a branch of the sacral plexus, and appears in the gluteal region at the lower border of the pyriformis. It passes downwards under cover of the gluteus maximus and below its lower border proceeds distally on the back of the thigh, immediately under the deep fascia. It becomes cutaneous in branches to the back of the thigh, popliteal region, and upper part of the calf. In the gluteal region it gives off cutaneous twigs which wind round the lower border of the gluteus maximus, and the **long perineal** nerve which enters the perinæum in front of the tuberosity of the ischium.

The **great sciatic nerve** (Fig. 31) is the largest trunk of the sacral plexus, and appears at the lower border of the pyriformis ; or occasionally it appears as two trunks, the upper of which pierces that muscle. It runs downwards under cover of the gluteus maximus lying upon the obturator internus and gemelli, quadratus femoris, and adductor magnus muscles. At the lower border of the gluteus maximus it lies between the ischial tuberosity and the great trochanter and close to the medial side of the neck and lesser trochanter of the femur, and then disappears beneath the hamstring muscles. Usually this nerve gives off no branches in the gluteal region, but the nerve to the quadratus is sometimes derived from it instead of from the sacral plexus itself, and the branches to the hamstrings may arise as high as the quadratus femoris. It terminates about the middle of the thigh by dividing into the medial and lateral popliteal nerves.

In order to trace out the remaining vessels and nerves of this region, the student should flex the knee, by raising the foot on a block, and so relax the sciatic nerve. This nerve trunk should then be pulled laterally, and working carefully on the spine of the ischium the dissector should clean the **internal pudendal nerve** and **artery**—the nerve lying medial to the artery, and immediately lateral to them, and lying directly on the bone, he should secure and trace downwards the **nerve to the obturator internus**, and then the **nerve to the quadratus femoris.**

The **internal pudendal artery** (Fig. 31) is seen only in a small part of its course, namely, where it crosses over the spine of the ischium. It emerges from the great sciatic foramen below the pyriformis and enters the perinæum through the lesser foramen, above the tendon of the obturator internus. The artery is accompanied by its venæ comites and by two nerves, the internal pudendal nerve lying to its medial side and the nerve to the obturator internus lying laterally.

The **internal pudendal nerve** (Fig. 31) (from the sacral plexus) is seen lying on the apex of the spine of the ischium medially to the pudendal vessels. It accompanies the pudendal artery into the perinæum, where it gives off its first branches.

The **nerve** to the **obturator internus** (Fig. 31) arises from the upper part of the sacral plexus, and leaves the pelvis below the pyriformis, taking the same course as the pudendal vessels and nerve over the spine of the ischium, but lying to their lateral side. As it winds into the lesser sciatic foramen it gives a branch to the superior gemellus muscle and then supplies the fibres of the obturator muscle.

The **nerve** to the **quadratus femoris** (Fig. 31) arises from the sacral plexus, and passes with a branch from the sciatic artery beneath the gemelli and the obturator internus tendon. It supplies the inferior gemellus muscle as well as the quadratus.

The tendon of the obturator internus, with the gemelli attached, should be divided near its insertion and turned towards the margin of the lesser sciatic foramen. A large bursa will be displayed beneath it, and this will be seen to lubricate the under surface of the tendon and the marginal surface of the foramen. The ischial surface of the tendon is subdivided by two or three deep grooves, and the surface of the bone is encrusted with cartilage which presents ridges corresponding with these. The tendon of the pyriformis should also be divided, and the muscle turned medialwards, so that the intra-pelvic position of its origin may be ascertained. The small arteries found at the upper and lower borders of the quadratus should now be dissected out. The upper vessel is a branch of either the medial femoral circumflex or the obturator artery, and runs laterally to anastomose with the lateral femoral circumflex artery; and the lower, which is more constant, is another of the terminal branches of the medial circumflex artery. These vessels also

anastomose with the sciatic artery above, and with the first perforating branch of the profunda femoris below. This series of inosculations is termed the "crucial anastomoses," and represents the "collateral circulation," which would re-establish the blood supply of the lower limb, if the main vessel, femoral or external iliac arteries, were ligatured. The quadratus femoris should then be divided, and its nerve supply established. The dissector should then proceed to reflect, by blunt dissection, the gluteus minimus downwards from its origin, and examine the structures which lie below it. These are, a bursa, intervening between its tendon and the great trochanter; the reflected tendon of the **rectus femoris**, lying in a groove along the upper margin of the acetabulum; and the posterior part of the capsule of the hip joint, which should be noted to be thin. The student must be careful to examine the origins of the hamstring muscles at this stage, as it is improbable that he will have a further opportunity to do so. They take origin from the posterior surface of the tuberosity of the ischium, the **biceps** and **semi-tendinosus** arising conjointly and superficially to the **semi-membranosus**. The biceps is tendinous at its origin, and is placed laterally to the semi-tendinosus, which is fleshy.

THE FRONT OF THE THIGH

The body is now placed on its back with the pelvis well raised from the table by blocks. A superficial dissection of the whole area between the groin and the knee is first carried out, and afterwards deep dissections of the front and medial side of the thigh. The hip joint should then be examined, and the limb removed from the trunk at the end of two weeks.

Surface Anatomy.—The "fold of the groin" separates the thigh from the abdomen, and the finger, if carried along it, will detect the **inguinal (Poupart's) ligament**, tightly stretched when the limb is fully extended, but relaxed when the thigh is flexed. **Lymphatic glands** of variable size can be felt along, or a little above, the line of the ligament, while below it others may be felt extending vertically down the thigh a little medial to the middle line. The **femoral artery**, which may be followed for about a third of the length of the thigh, should be palpated; at the fold of the groin it lies midway between the anterior superior spine of the ilium and the **symphysis pubis**, and from there its course is downwards and medialwards. The **saphenous vein** is occasionally to be seen on the inner side of the limb. The anterior superior spine and the

crest of the ilium will be readily seen and felt. The **tubercle** and **crest** of the **pubis**, the former an extremely important landmark in connection with hernia, are also to be distinguished, and the **tuberosity** of the **ischium** is to be felt by running the finger downwards along the **pubic arch**. The **great trochanter** is easily recognised; it is placed three or four inches below the iliac crest. The position of the **hip joint** may be defined by drawing downwards a line an inch long at right angles to the middle of the inguinal ligament. The lower end of this line corresponds to the head of the femur, which may be felt in a very thin subject. The **condyles** of the **femur**, the **adductor tubercle** on the medial condyle, and the **patella** are to be examined, and it should be noticed how large a part of the articular end of the femur is uncovered when the knee is flexed. The **ligamentum patellæ** and its attachment to the tibia are to be felt, and the **condyles** of the **tibia** are to be recognised. The head of the **fibula** is readily felt behind and below the lateral condyle, and at the back of the knee joint the tendons of the **hamstring** muscles can be distinguished as forming the medial and lateral boundaries of the **popliteal space**.

SUPERFICIAL DISSECTION OF THE THIGH

An incision is to be made along the whole length of the inguinal ligament, and another from its medial end downwards along the medial side of the thigh to below the medial condyle of the tibia; and a third is to be made from the lower end of the vertical incision transversely lateralwards to the lateral border of the leg. The flap of skin thus marked out is to be raised from the subjacent fascia and turned laterally. The superficial fascia is then to be examined, the student working in conjunction with the dissectors of the abdomen

The **superficial fascia** of the thigh is continuous over the inguinal ligament with the superficial fascia of the abdominal wall, and generally contains a good deal of fat, particularly in the female subject. It is divisible into two layers in the uppermost part of the thigh, the separation between the two layers being marked by some small vessels, by lymphatic glands, and minute nerves. To understand the connections of these layers, it is necessary to know that on the lower part of the abdominal wall the superficial fascia consists of two distinct layers. One, a fatty layer, the fascia of **Camper**, is continuous over the inguinal ligament with the superficial fascia of the thigh; the other, a deeper layer, membranous and devoid of fat, the fascia of **Scarpa**, when traced downwards from the

abdominal wall, fuses with the deep fascia (the fascia lata) of the thigh immediately below the inguinal ligament. It will be recognised then, that if fluid (urine) were to be effused under the two layers of the superficial fascia of the abdominal wall, its passage into the front of the thigh would be prevented by the attachment of the fascia of **Scarpa** to the fascia lata. The dissector of the thigh should associate himself with the dissector of the abdomen in the demonstration of the two layers. In the superficial fascia of the thigh there are blood vessels, nerves, and lymphatic glands to be dissected out.

The **superficial arteries** are branches of the femoral artery, and are three in number ; they pierce the deep fascia just below the inguinal ligament and supply the glands and the skin in the inguinal region. The **superficial epigastric** artery passes upwards and medialwards over the front of the abdomen. The **superficial circumflex iliac** artery is a small branch running laterally a little below the inguinal ligament towards the anterior superior spine. The **superficial external pudendal** artery runs medially over the spermatic cord to the scrotum, or to the labium in the female.

Small **superficial veins** correspond in course to these arteries, and will be seen to open into the **long saphenous** vein. This large vessel (Fig. 32), which commences at the medial end of a venous arch on the dorsum of the foot, enters the thigh at the back of the medial side of the knee. After receiving branches from the front and back of the limb, it inclines anteriorly and passes through the saphenous opening (fossa ovalis) to terminate in the femoral vein. The dissection of its proximal part should be postponed meantime. The other superficial veins of the thigh are very variable, and either open into the saphenous vein separately or join to form one or more branches which enter the main trunk at or near the saphenous opening.

The **superficial lymphatic glands** (Fig. 32) will be found arranged in two groups. One group extends obliquely along the fold of the groin, and receives the lymphatics of the external genitals and perinæum medially, those of anal region and nates laterally ; the lymphatic vessels from the abdominal wall below the umbilicus drain into the central glands. The other group runs vertically below the groin along the saphenous vein, and drains the superficial lymphatics of the whole limb. A few deep lymphatic glands will be afterwards met with round the upper part of the femoral vessels. These drain the deep parts of the lower extremity, and the superficial group is connected with them by lymphatic vessels passing through the saphenous opening.

The **cutaneous nerves** of the front of the thigh (Fig. 32) are derived either directly from the **lumbar plexus** or from the **anterior femoral nerve**—itself a branch of that plexus. The main nerves —the **lateral, anterior,** and **medial cutaneous**—are longitudinal trunks reaching to the knee, and are to be sought in their appropriate positions through longitudinal incisions in the superficial fascia. The other cutaneous nerves are of small size and difficult to secure.

The **lateral cutaneous** nerve of the thigh, a direct branch of the lumbar plexus, is to be found amongst some fat in a fold of fascia lata close to

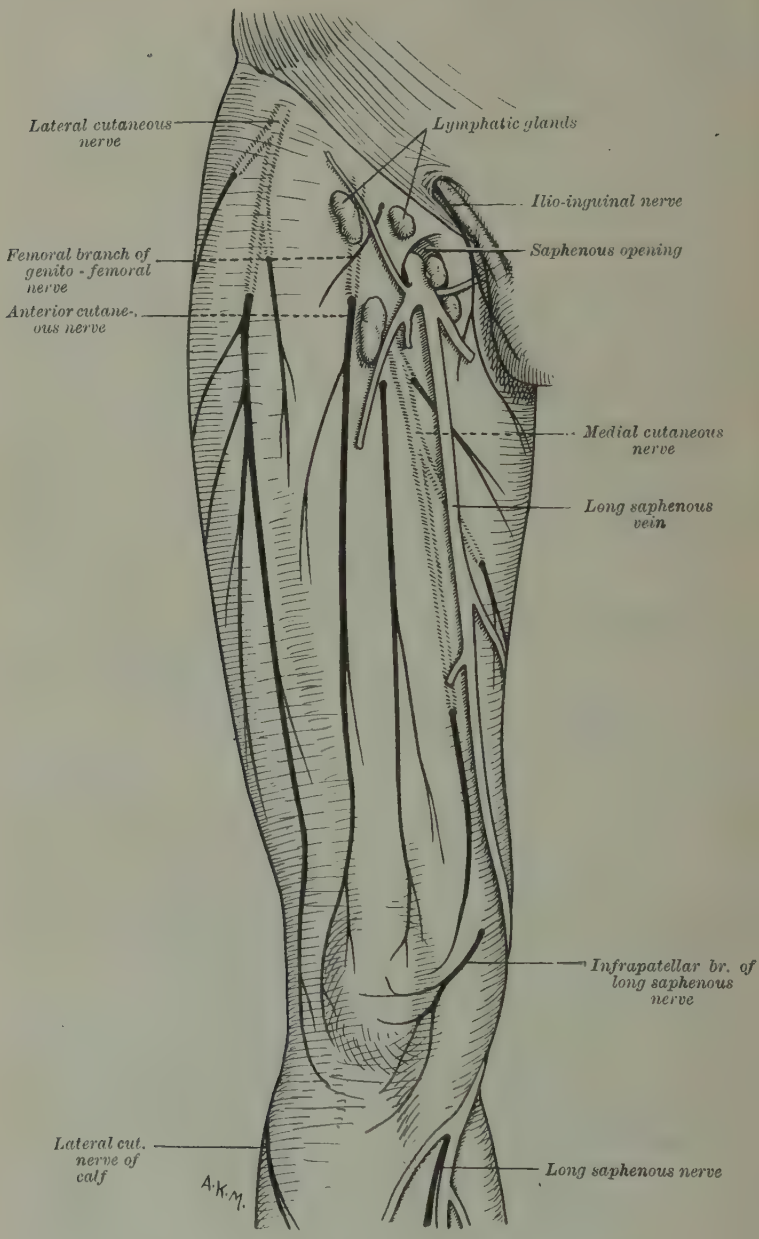


FIG. 32.

The superficial structures of the front of the thigh.

the anterior superior spine of the ilium. It pierces that fascia at a variable point (two to four inches below the spine), and is distributed by anterior and posterior branches on the lateral side of the thigh as far as the knee. The **anterior** (intermedial) **cutaneous** nerve, from the anterior femoral, pierces the fascia lata in the middle line of the upper third of the thigh, usually in two parts, and these may be traced as far as the knee. This nerve, or its lateral branch, usually pierces the sartorius muscle. The **medial cutaneous** nerve, also a branch of the anterior femoral, gives two or three twigs to the upper and medial parts of the thigh, and crosses to the medial side of the femoral artery. It divides into two branches, anterior and posterior, which perforate the deep fascia at some distance from one another. The anterior branch becomes cutaneous in the lower third of the thigh in front of the long saphenous vein, and reaches as far as the knee; the posterior branch crosses to the posterior side of the saphenous vein a little above the knee, and supplies the skin on the medial side above and below the knee joint.

The **ilio-inguinal** nerve (Fig. 32), which becomes superficial on the abdominal wall close to the pubic tubercle, in its course to the scrotum or labium gives one or two small branches to the medial and uppermost parts of the thigh. The **femoral branch** of the **genito-femoral** nerve (Fig. 32) pierces the fascia lata half an inch below the inguinal ligament and just lateral to the femoral artery, and usually joins the anterior cutaneous nerve. It is very seldom satisfactorily seen unless traced from the lumbar plexus. The **saphenous nerve** (Fig. 32) (the course of which will be seen afterwards) becomes cutaneous on the medial side of the knee between the tendons of the sartorius and gracilis muscles. Before becoming cutaneous itself, it sends forward a branch, the infrapatellar nerve, which pierces the sartorius muscle and unites with branches of the lateral, anterior, and medial cutaneous nerves, to form a plexus in front of the patella, "the patellar plexus."

The remains of the superficial fascia and the lymphatic glands should now be removed, the student commencing at the lower part of the thigh and working upwards towards the inguinal ligament. Care must be exercised to leave intact the deep fascia, the **fascia lata**, which in some parts is very thin; and careful dissection, or the assistance of a demonstrator, is required to display the **saphenous opening** in it at the upper part of the limb.

The **fascia lata** is the name given to the deep fascia of the thigh, and it will now be seen to be a strong fibrous covering of the thigh muscles. In the middle and lower portions of the thigh, it forms a continuous circular investment of the thigh, passing completely round the limb. In the neighbourhood of the knee joint, it is attached to the various bony prominences, and posteriorly is continuous with the popliteal fascia. The portion of the fascia on the lateral side of the limb is of remarkable strength. It receives from above the insertion of the **tensor fasciæ latæ** muscle and part of the gluteus maximus, both of which it encloses; its upper attachment is to the crest of the ilium, and below it is fixed to the

lateral border of the patella, to the ligamentum patellæ, and to the lateral condyle of the tibia and head of the fibula. This part is therefore usually called the **ilio-tibial band** (Fig. 34). On the medial side of the thigh the fascia lata is much thinner, and the subjacent muscles can be seen through it.

From its deep surface the fascia lata sends inwards, to be attached to the posterior aspect of the femur, three strong intermuscular septa (Fig. 33). A lateral septum separates the vastus lateralis from the flexor (hamstring) group of muscles, a medial

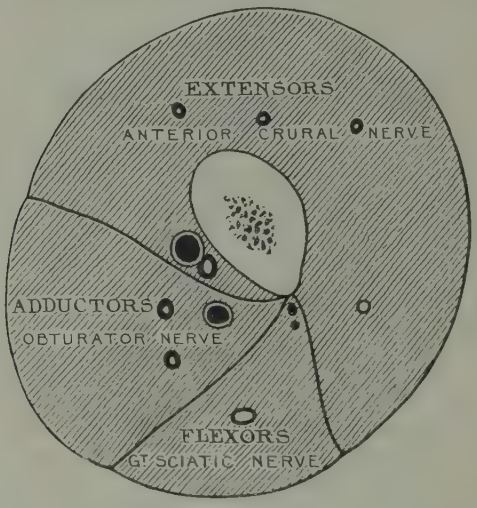


Fig. 33.

The thigh in transverse section (diagrammatic).

intervenes between the vastus medialis and the adductors, and a posterior septum, not so strong as the others, lies between the adductor and the flexor muscles. By means of these septa the thigh may be divided into three compartments, each containing a group of muscles and the "group nerve" which supplies them; an anterior or extensor compartment, with the anterior crural nerve; a posterior or flexor compartment, with the great sciatic nerve; and a medial or adductor compartment containing the obturator nerve. The student will appreciate that this division of the thigh muscles into groups, and the supply of each group by its own particular nerve, is a serviceable aid towards remembering the nerve supply of the individual muscles.

At the upper extremity of the limb, the fascia lata is continuous posteriorly with the gluteal fascia, and is thus attached to the coccyx, sacrum, and crest of the ilium ; on the medial side, it is fixed along the pubic arch, from the tuberosity of the ischium forwards to the symphysis pubis ; but anteriorly its attachment is complicated by the presence of the **saphenous opening**.

The **saphenous opening** (Fig. 32) is an oval cleft about one and a half inches long and nearly half an inch wide, and divides the upper part of the fascia lata into a lateral or iliac portion and a medial or pubic portion. The iliac part is attached above along the whole length of the inguinal ligament, covering over the femoral vessels which lie immediately deep to it. Its medial free border, the "falciform margin," forms the lateral boundary of the saphenous opening, and has a well defined curve, concave medialwards. Inferiorly it forms the lower boundary ("inferior cornu") of the opening, and is continuous with the pubic portion of the fascia underneath the saphenous vein. The pubic fascia covers the adductor longus and pectineus muscles, and forms an indefinite medial limitation of the saphenous opening. When traced laterally this portion of the fascia lata recedes from the surface, passes behind the femoral vessels, and fuses with the capsule of the hip joint and with the iliopsoas fascia. It is attached above along the anterior part of the iliopectineal line. In the undissected condition the saphenous opening is closed over by a thin layer of deep fascia, perforated by the saphenous vein and by numerous lymphatic vessels, and thence called the **fascia cribrosa**. The saphenous opening is usually better seen in the female subject, and it is surgically important, since it is the aperture through which a femoral hernia emerges towards the surface. It should be observed that the margins of the opening are relaxed when the thigh is flexed.

DEEP DISSECTION OF THE FRONT OF THE THIGH
(Extensor Region)

The fascia lata should be removed from the surface of the upper part of the **sartorius** muscle, which crosses the thigh from above downwards and medialwards, and then from the **adductor longus**, a superficial and medial muscle of the upper part of the thigh (Fig. 34). The inguinal ligament should be defined. These structures are the boundaries of a triangular hollow, the **femoral (Scarpa's) triangle**, to which, with its contents, the student should now direct his attention.

The **femoral (Scarpa's)** triangle (Fig. 34) is a superficial intermuscular space in the upper third of the front of the thigh. The base of the triangle is formed by the inguinal ligament, the lateral border by the medial edge of the sartorius, and the medial boundary is the medial edge of the adductor longus. The apex of the triangle is below where the sartorius crosses the adductor longus. In the floor of the space, there are to be recognised and cleaned, the

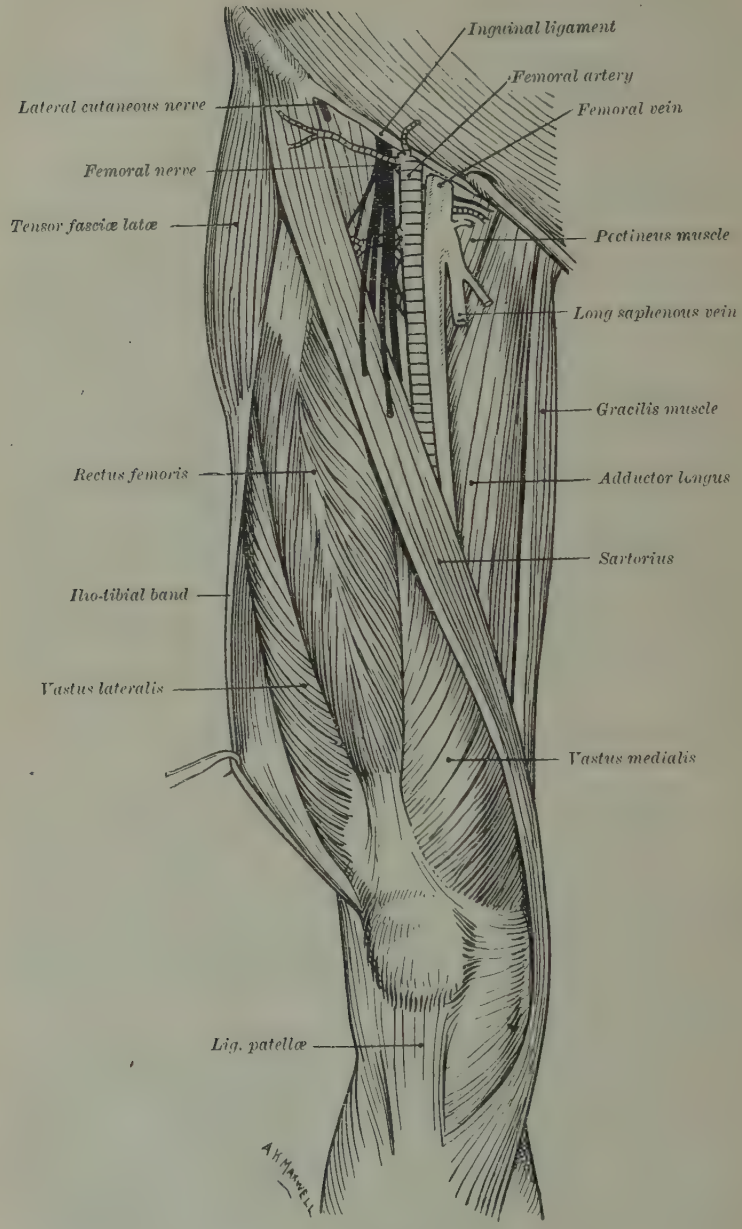


FIG. 34.

Superficia dissection of the thigh.

adductor longus, pectineus, psoas, and **iliacus** muscles, in that order from the medial side. The triangle contains the commencement of the **femoral artery** and its **profunda** branch; the **femoral vein** and its tributaries (including the saphenous vein after it has pierced the fascia cribrosa); a few deep lymphatic glands; and the **anterior femoral** (or **crural**) nerve, lying in the groove between the psoas and iliacus.

The **sartorius muscle** (Fig. 34), which should not be raised from the subjacent muscles at present, but its superficial surface cleaned throughout its whole length, arises from the anterior superior spine of the ilium and from the notch below it. The muscle crosses obliquely over to the medial side of the thigh, winds behind the medial condyle of the femur, and then forwards below the medial condyle of the tibia, and ends in a broad aponeurosis, which is inserted into the medial surface of the shaft of the tibia behind its tuberosity. The lower border of the aponeurosis blends with the fascia of the leg and its upper border with the capsule of the knee joint, and it overlaps the insertions of the gracilis and semitendinosus muscles. It is pierced by one or more of the anterior cutaneous branches of the anterior femoral nerve.

The **inguinal (Poupart's) ligament** (Figs. 34 and 35) belongs to the abdominal wall, but it should be studied by the dissector of the leg. It is attached laterally to the anterior superior iliac spine, and medially to the pubic tubercle. From the medial end (about half an inch) of the inguinal ligament, a strong band of fibres reaches downwards to be attached to the anterior end of the ilio-pectineal line. This second ligament, the **lacunar (Gimbernat's)** ligament, thus fills the angle between the inguinal ligament and the pubic bone, and its crescentic free edge is directed lateralwards towards the femoral vessels. The inguinal ligament affords attachment to the fascia lata of the thigh.

The dissector must now expose the **sheath of the femoral vessels** by separating the iliac portion of the fascia lata from the inguinal ligament and turning it downwards. Carefully remove the small amount of loose fat surrounding the sheath, and with the handle of the knife isolate it from the inguinal ligament above, and from the lacunar ligament on its medial side.

The **sheath** of the **femoral vessels** (Fig. 35) lies between the iliac part of the fascia lata in front and the pubic fascia behind. The sheath appears as a tube, broader above than below, and is composed of a delicate connective tissue, containing more or less fat. It invests the femoral artery and vein and a few of the deep lymphatics, and may be traced upwards into the abdomen beneath the inguinal ligament. Below, it blends with the walls of the contained vessels about the level of the lower end of the saphenous opening. It is formed by the fusion of the lining fasciæ of the abdomen –the fascia transversalis of the anterior abdominal wall and the fascia iliaca of the posterior

wall—round the femoral vessels, which at their commencement are placed between those layers. Three vertical incisions, one in the centre and one at each side of the sheath, will enable the dissector to see that it is divided by two slender septa into three compartments, the femoral artery occupying the lateral compartment, the femoral vein the middle, and subperitoneal fat and a lymphatic gland the medial and smallest one. This last division of the femoral sheath is the **femoral** (or **crural**) **canal**. If the little finger be pushed upwards along the femoral canal, it will pass beneath the inguinal ligament and enter the abdominal

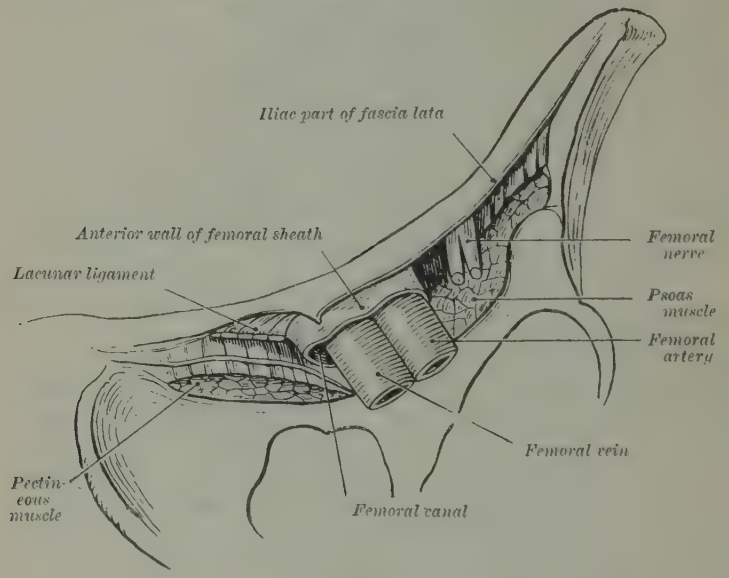


FIG. 35.

The femoral canal and its relations (diagrammatic).

cavity through the abdominal opening of the canal, which is termed the **femoral ring**. A lymphatic gland, and a small piece of subperitoneal fat, the latter forming the "septum femorale," occupy the canal, and will have to be displaced. The boundaries of the femoral ring can now be felt, and are: in front, the inguinal ligament (with occasionally a distinct band of fascia transversalis beneath it, called the deep femoral arch); behind, the pubic bone, lateral to its tubercle, covered by the pectineus muscle; laterally, the femoral vein, and medially, the sharp margin of the lacunar (Gimbernat's) ligament. The femoral ring is the aperture through which a femoral hernia leaves the abdomen, and the point at which strangulation most commonly occurs, and the femoral canal is the canal, half an inch in length, along which the hernia descends from the femoral ring towards the saphenous opening. The finger should, therefore, thoroughly explore the canal, and its relations should be carefully determined.

The femoral vessels should now be cleaned so far as they lie in

the femoral triangle, care being taken to secure the branches—the three superficial vessels already noted, the **deep external pudendal** artery running medialwards on the pectineus muscle, and from the lateral side of the femoral artery the large **profunda femoris** artery with its **medial** and **lateral femoral circumflex** branches. The **anterior femoral** (or **crural**) nerve should be obtained lying between the psoas and iliacus muscles, and, as far as the limits of the space will allow, its branches should be followed out. The muscles forming the floor of the triangle should then be finally cleaned, the adductor longus and pectineus on the medial side of the femoral artery, and to its lateral side the psoas and iliacus. In cleaning the pectineus care must be taken to secure its nerve, from the anterior femoral, which lies on its surface, after emerging from below the femoral vessels.

The **femoral artery** in the **femoral triangle** (Fig. 34).—The femoral artery is the continuation of the external iliac artery of the abdomen, and extends from the inguinal ligament downwards through the thigh to the opening in the adductor magnus muscle through which it passes into the popliteal space. When the thigh is slightly flexed and abducted, the artery runs from a point midway between the symphysis pubis and the anterior superior iliac spine along a line to the prominent adductor tubercle on the medial condyle of the femur. The part of the vessel now exposed is that above the point crossed by the sartorius, and is usually about a half of the whole length of the trunk. This portion of the artery, lying at first within its sheath, is covered only by the superficial fascia and the fascia lata, and one or two branches of the medial cutaneous nerve cross it at variable points. Behind the artery from above downwards there are the psoas muscle, separating it from the head of the femur ; the nerve to the pectineus, a branch of the anterior femoral nerve ; the pectineus itself, separated from the femoral artery by its profunda femoris branch and the femoral vein ; and the adductor longus. Occasionally between the pectineus and adductor longus a small portion of the adductor brevis is to be seen. To the lateral side of the upper part of the vessel, separated, however, by the psoas tendon, is the anterior femoral nerve ; but its long saphenous branch and the nerve to the vastus medialis, the latter to the lateral side of the former, are in close relation with the lower part of the artery. The femoral vein lies on the medial side of the artery near the inguinal ligament, but lower down passes behind the artery, and forms one of its posterior relations at the apex of the triangle.

The **branches** of the femoral artery in this region are : 1. The small vessels already dissected in the superficial fascia. 2. A larger branch, the **deep external pudendal**, which runs medially on the pectineus, and piercing the fascia lata ends in the scrotum or labium. 3. The largest branch, the **profunda femoris** artery, which arises one to two inches below the inguinal ligament. It is seen first to the lateral side of, and then behind, the femoral artery and vein, and rests upon the iliacus and then on the pectineus muscle. (Should, however, the lateral circumflex branch arise from the femoral instead of from the profunda, the commencement of the latter vessel lies behind or even on the medial side of the femoral.) The profunda will be dissected afterwards, but the

commencement of its lateral and medial circumflex branches should be exposed at present, since they lie within the femoral triangle.

The fascia lata should now be removed from the rest of the front of the thigh, leaving intact, however, the ilio-tibial band. The cutaneous nerves are to be preserved. The muscles of the front of the thigh are to be cleaned. The whole anterior mass of muscle is termed the **quadriceps extensor cruris** (Fig. 34), and comprises four muscles inserted together by means of a common tendon into the patella, and thence through the **ligamentum patellæ** into the upper end of the tibia. The **rectus femoris** is the superficial muscle, and below it is the **crureus**, which is partly covered at the sides by the **vastus lateralis** and **vastus medialis**. The sartorius muscle is then to be pulled laterally, and the **adductor (Hunter's) canal** opened by division of its fascial roof—a tendinous expansion stretching from the vastus medialis in front to the adductors longus and magnus behind. The femoral artery and vein are to be followed through the canal to their passage through the **adductor magnus**.

The **adductor (Hunter's) canal** (Fig. 36) is now seen to be an intermuscular space in the middle third of the thigh, continuous with the apex of the femoral triangle above and with the popliteal space below through the adductor magnus muscle. It contains the femoral vessels and the saphenous nerve. The space is bounded posteriorly by the adductor longus and lower down by the adductor magnus, laterally and in front by the vastus medialis, and is roofed over by the strong fibrous membrane stretching between these muscles and on top of which the sartorius muscle is placed.

The **femoral artery** in the **adductor canal** (Fig. 36).—On laying open the canal, the femoral artery will be seen with the femoral vein behind and to its lateral side. (A second smaller vena comes is sometimes seen on the opposite side.) With the vessels is the saphenous nerve, and lateral to this the nerve to the vastus medialis giving off twigs to the muscle. The saphenous nerve lies at first to the lateral side of the artery, but lower down crosses over it and then winds round the tendon of the sartorius to become cutaneous on the medial side of the knee. The femoral artery passes through the opening in the adductor magnus and enters the popliteal space as the popliteal artery. Except some unnamed muscular branches, the only branch of the femoral artery in the canal is the **arteria anastomotica magna**. It arises just above the opening in the adductor magnus, and divides almost at once into superficial and deep branches. The superficial (saphenous) branch accompanies the saphenous nerve to the skin ; and the deep, an articular, branch enters the vastus medialis and through it descends to the knee to anastomose with the medial articular branches of the popliteal artery, and also sends a branch to the lateral side, above the patella, to join with the superior lateral articular artery.

The **femoral vein** (Fig. 34) begins at the opening in the adductor

magnus muscle as the continuation of the popliteal vein from the popliteal space, and passing through the adductor canal and the femoral triangle, runs under the inguinal ligament to become the external iliac vein. In the adductor canal, and at the lower part of the femoral triangle, the vein lies behind and sometimes a little to the lateral side of the artery. It then crosses obliquely behind it, and after being joined by the profunda vein, reaches the medial side of the femoral artery at the upper part of the femoral space. There it receives the saphenous vein, which has previously been joined by the veins corresponding to the small branches of the artery (superficial epigastric, circumflex iliac, and deep external pudendal). Below the inguinal ligament the vein occupies the centre compartment of the femoral sheath, and forms the lateral wall of the femoral canal. The vein should be slit open, as the arrangement of the venous valves within it can often be seen.

The branches of the **anterior femoral** (or **crural**) nerve are to be followed out from the parent trunk, and will be seen to form naturally two groups—a superficial cutaneous set, whose only muscular branches are those to the sartorius; and a deep group, which, with the exception of the long saphenous nerve, is distributed entirely to the muscles of the front of the thigh.

The **anterior femoral** or **crural nerve** (Fig. 36) is derived from the lumbar plexus, and enters the thigh beneath the inguinal ligament, resting upon the adjacent borders of the psoas and iliacus muscles. It breaks up into superficial and deep divisions, which are separated by the lower branches of the lateral femoral circumflex vessels. The superficial division gives off the anterior and medial cutaneous nerves of the thigh, and supplies the sartorius muscle. The deep division supplies muscular branches to the pectineus, rectus femoris, crureus and vasti muscles, a slender twig to the subcrureus muscle (which will be secured later), and gives off the long saphenous cutaneous nerve. The branches to the sartorius are two or three in number, and as a rule arise in common with the anterior cutaneous nerve. The nerve to the pectineus passes beneath the femoral sheath to reach the muscle. The nerve to the rectus femoris gives a branch to the hip joint, and those to the vasti give twigs to the knee joint. The **saphenous nerve** is the largest branch of the anterior crural; it lies close to the lateral side of the femoral artery, and enters the adductor canal with it. It crosses the artery near the lower end of the canal, and having pierced the membranous roof, appears from beneath the sartorius at the medial side of the knee. In the thigh it gives a communicating branch to the subsartorial plexus, and at the knee its patellar branch pierces the sartorius, and ends in the patellar plexus. The main trunk becomes cutaneous between the sartorius and gracilis, and runs down the medial side of the leg as far as the ankle joint, and with care can be traced to the medial side of the foot.

The **subsartorial plexus** is situated beneath the sartorius muscle, and on the roof of the adductor canal. It is a plexiform intercommunication between branches of the saphenous, the medial cutaneous, and usually a branch from the superficial division of the obturator nerve.

The **quadriceps extensor** muscle mass is now to be separated into its four components, the origins of which are to be defined.

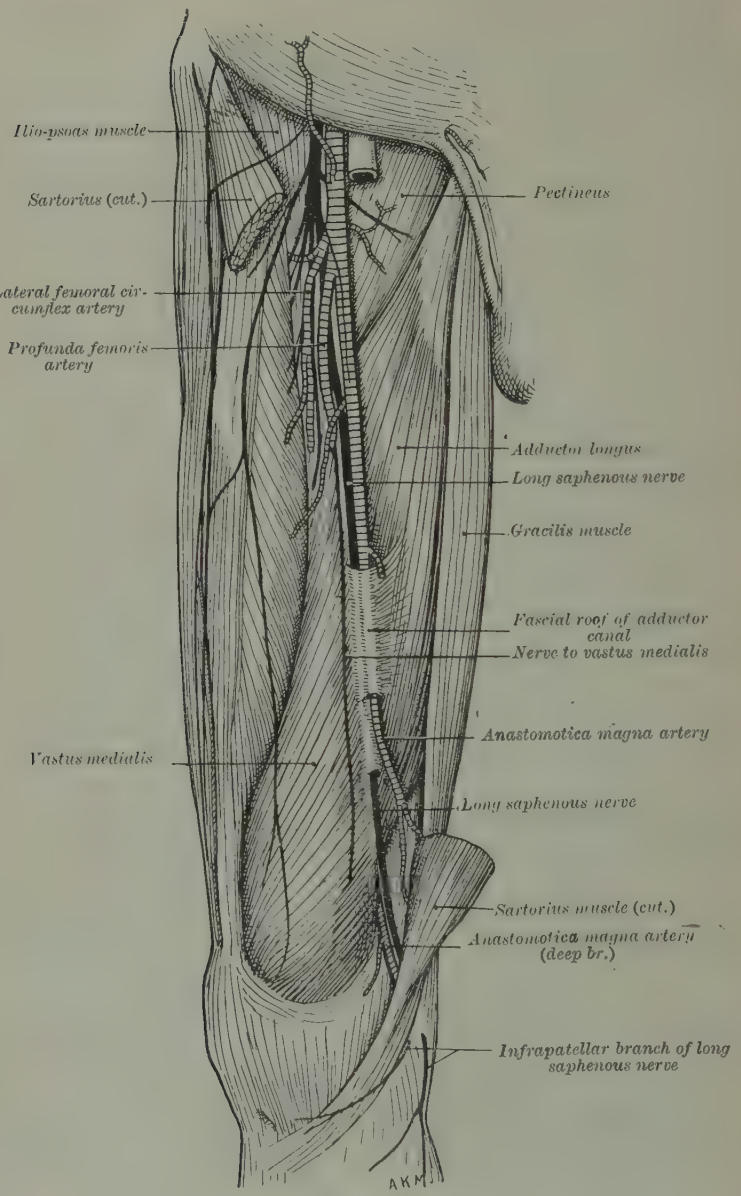


FIG. 36.

Deep dissection of the front of the thigh.

There is usually some difficulty in distinguishing the intervals between the vasti, especially the medialis, and the crureus, but considerable help will be gained by studying the direction of the muscle fibres. Those of the crureus run vertically, those of the vasti downwards and forwards. The **tensor fasciæ latæ** immediately lateral to the upper part of the sartorius, is to be exposed by removing the covering part of the ilio-tibial band, and beneath it the insertions of the gluteus medius and minimus should be seen. The terminal branch of the **superior gluteal** nerve is to be traced into its substance.

The **rectus femoris** (Fig. 34) has no attachment to the femur, but stretches over it from the pelvis to the patella. It arises by two tendons, one from the anterior inferior spine of the ilium, and the other, the reflected head, already seen below the gluteus minimus, from a rough impression above the acetabulum. The reflected tendon may be easily exposed by separating the tensor fasciæ latæ and the rectus, and clearing away the fat and connective tissue from the deep interspace between them with the handle of the scalpel. The rectus is a typical bipenniform muscle, tendinous on its superficial surface in its upper part, and on its deep surface at the lower part. It passes to be attached to the upper border and anterior surface of the patella in conjunction with the other extensor muscles. A few fibres, which pass in front of the patella, form the superficial portion of the ligamentum patellæ, and with it reach the tubercle of the tibia—the true insertion of the quadriceps. The crureus joins the back of the rectus tendon above the patella, and the marginal vasti are attached to its borders, so that the tendon is sometimes referred to as that of the quadriceps extensor. It should be noticed that the straight head of the rectus is in the axial line of the muscle during extension of the thigh, but that the reflected head is so during right-angled flexion.

The **tensor fasciæ latæ** (Fig. 34) arises from the lateral side of the anterior superior spine of the ilium, and from part of the notch below. The muscle passes downwards and backwards to be inserted into the fascia lata (ilio-tibial band), below the great trochanter, the fascia being split at this point to receive the muscular fibres.

Beneath the rectus there will be seen the **lateral femoral circumflex** branch of the profunda artery. It is to be traced transversely between the branches of the anterior femoral (or crural) nerve, lying upon the vastus lateralis and beneath the sartorius and rectus femoris, to the lateral side of the thigh, where it divides into ascending, transverse, and descending sets of branches. The ascending branches pass beneath the tensor fasciæ latæ to anastomose with the gluteal and the deep circumflex iliac arteries, and give twigs to the hip joint. The transverse set supply the vastus lateralis, and, turning round the limb, anastomose posteriorly with the upper perforating branches of the profunda femoris and assist in forming the crucial anastomosis. The descending branch passes into the vastus lateralis with the nerve to that muscle, and ends at the knee joint, where it anastomoses with the superior lateral articular branch of the popliteal, and with the anastomotica magna.

The **vastus lateralis** (Fig. 34) is the largest of the three muscles which clothe the front of the femur. It arises from the great trochanter,

from the gluteal ridge and the upper half of the lateral lip of the linea aspera, and extensively from the lateral intermuscular septum. Its fibres end in a broad aponeurosis which is inserted into the tendon of the rectus and independently into the upper part of the lateral border of the patella, aiding in the formation of the capsule of the knee joint. Its upper superficial fibres are sometimes detached from the rest by a deep intermuscular space.

The **vastus medialis** (Fig. 34) is more or less united with the crureus. It arises from the lower half of the anterior intertrochanteric line, from the medial lip of the linea aspera, and from the medial intermuscular septum. It is inserted into the rectus tendon, and independently into the upper half of the medial side of the patella. Like the vastus lateralis it helps to form the capsule of the knee joint.

The **crureus** (Fig. 36) covers the front of the femur between the two vasti and beneath the rectus. It arises from the upper part of the intertrochanteric line, and from the anterior and lateral surfaces of the femur to about four inches from the lower end of the bone. It is inserted into the patella in common with the other extensor muscles. Its surface is tendinous, to allow free movement of the rectus upon it. Its lowest fibres of origin form the **subcrureus**, which will be dissected with the knee joint.

THE MEDIAL SIDE OF THE THIGH. (Adductor Region)

The most superficial of the **adductor** group of muscles—the **adductor longus**—is already exposed; to allow of the complete exposure of the remainder of this region the skin must be reflected from the medial aspect of the thigh as far as the tuberosity of the ischium. The **gracilis** muscle, descending vertically along the medial margin of the thigh, is to be brought into view and cleaned along its whole length by removal of the covering fasciæ. The femoral vessels and the branches of the anterior femoral (crural) nerve are to be tied together and divided just below the inguinal ligament, so that they may be turned downwards.

The **adductor longus** (Fig. 36) arises by a rounded tendon from the front of the pubis immediately below its crest. It broadens out below and is inserted into the medial lip of the linea aspera of the femur by a thin aponeurosis, which is usually more or less blended with the insertions of the underlying adductors brevis and magnus. The muscle separates the femoral artery from its profunda branch, the latter disappearing from the femoral triangle above its upper border, and continuing downwards beneath it.

The **gracilis** (Fig. 36) is a long strap-shaped muscle, and is the most medial muscle of the thigh. It arises by a thin tendon from the lower border of the body of the pubis, and is inserted by a slender rounded tendon into the medial surface of the tibia under cover of the sartorius, a bursa intervening between the muscles.

The adductor longus is to be divided near its origin and turned downwards in order to expose the **adductor brevis** and the insertions

of the **pectineus** and **ilio-psoas**. The superficial division of the **obturator nerve**—which lies between the adductors longus and brevis muscles—is to be secured, and its branches traced to the adductors longus and brevis and gracilis muscles. The **profunda femoris** artery is to be cleaned throughout its whole course, its **medial femoral circumflex** branch is to be traced over the upper border of the pectineus, and the **perforating** arteries, lying close to the bone, are to be followed through the fibrous arches in the substance of the adductors brevis and magnus.

The **insertion** of the **ilio-psoas**.—The **psoas** and **iliacus** muscles, which arise within the abdomen, are already partly conjoined as they enter the thigh under the inguinal ligament. The fleshy fibres of the iliacus are inserted into the lateral side of the tendon of the psoas, and the ilio-psoas tendon, as it is now called, continues almost vertically downwards to be inserted on the lesser trochanter of the femur. As a rule a few of the muscular fibres of the iliacus may be traced directly to the bone below this eminence.

The **pectineus** (Fig. 36) has already been seen as part of the floor of the femoral triangle, where it lies behind the femoral vessels and their profunda branches. It arises from the anterior end of the ilio-pectineal line and from the bone in front of it between the pubic tubercle and the ilio-pectineal eminence. It is inserted on the back of the femur into the line leading from the lesser trochanter to the linea aspera. Its nerve from the superficial division of the anterior crural was previously secured.

Reflect the pectineus from its origin downwards to its insertion, so as to expose that part of the adductor brevis which lies beneath it. Care must be taken to leave intact the superficial division of the obturator nerve, which descends behind the pectineus, and the medial circumflex artery which passes over its upper border.

The **adductor brevis** arises beneath the adductor longus from the front of the ramus of the pubis, and is inserted behind the pectineus into the line leading from the lesser trochanter to the linea aspera. It separates the two divisions of the obturator nerve.

The **profunda femoris artery** (Fig. 37) has been seen to arise from the lateral side of the femoral artery in the femoral triangle, and has been traced medialwards behind the femoral vessels on the surface of the pectineus muscle. It then dips inwards between the adjacent borders of the pectineus and adductor longus, and continues downwards behind the latter muscle, resting on the adductor brevis, and then on the adductor magnus. The profunda **vein** is superficial to its artery in the whole of its course, and terminates by joining the femoral vein. The branches of the profunda artery are : 1. The **lateral femoral circumflex**, which has already been examined in its course among the extensor muscles. 2. The **medial femoral circumflex**, which arises from the medial side of the profunda near its origin, and leaves the femoral triangle by dipping between the pectineus and psoas muscles. It gives off some muscular branches, detaches an articular branch to the hip joint which enters through the cotyloid notch, and then divides into two branches, ascending and transverse, both of which pass to the posterior aspect of the limb. The ascending

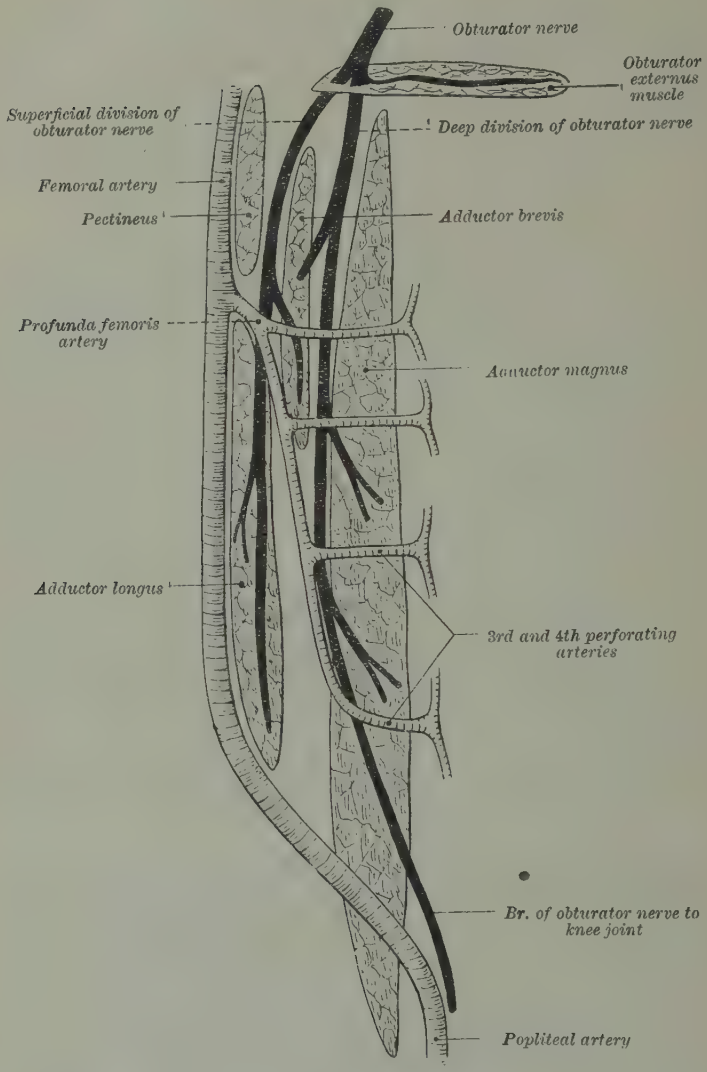


FIG. 37.

The adductor muscles in vertical section and their relations to the obturator nerve and profunda femoris artery.

branch follows the tendon of the obturator externus muscle, and was secured in the gluteal region at the upper border of the quadratus femoris; while the transverse branch passes backwards between the adductor magnus and the quadratus femoris, where it also was secured during the dissection of the gluteal region. The anastomoses of these vessels with the lateral femoral circumflex, and with the sciatic and first perforating arteries—in the "crucial anastomosis"—has already been described. 3. The **perforating** arteries (Fig. 31) arise in series, and are usually four in number. They are so called because they pierce the adductors close to the femur to reach the back of the thigh where they supply the hamstring muscles. The upper two vessels perforate the adductor brevis and adductor magnus, but the lower vessels, arising below the adductor brevis, perforate only the adductor magnus. In their passage through the muscles the arteries are covered over by fibrous arches. The four vessels form a longitudinal chain of anastomoses in and behind the adductor magnus, which, as already described, communicates above with the vessels of the gluteal region; subsequently the lowest vessel will be seen to anastomose with the arteries of the popliteal space. 4. The **nutrient** artery of the femur generally arises from the second perforating artery, and when entering the foramen in the linea aspera has a direction away from the knee.

The adductor brevis is to be divided near its origin and turned downwards in order to expose the deep division of the **obturator nerve**, the branches of which are to be followed out. The **adductor magnus** and the **obturator externus** muscle lying close to its upper border will also be brought into view, and are to be cleaned, and the tendon of the latter is to be followed laterally under the neck of the femur.

The **obturator** nerve (Fig. 37) is derived from the lumbar plexus. It leaves the pelvis at the upper part of the obturator foramen with the obturator artery, and divides into superficial and deep portions before piercing the obturator externus muscle. The superficial division passes downwards upon the adductor brevis, and supplies the adductor longus, the adductor brevis, and the gracilis, and gives off filaments to the subsartorial plexus, and an articular branch to the hip joint. The deep division supplies the obturator externus as it passes through it, and runs downwards behind the adductor brevis. It gives branches to the adductor magnus, and sends an articular filament through this muscle to the back of the knee joint. The adductor brevis is sometimes also supplied by this division. An **accessory obturator** nerve is occasionally to be found; it also arises from the lumbar plexus, but emerges from the pelvis over the pubic bone. It usually supplies the pectineus, and communicates with the superficial branch of the obturator nerve.

The **adductor magnus** (Fig. 37) arises from the whole length of the pubic arch and from the lower part of the ischial tuberosity. Its anterior fibres pass laterally with different degrees of obliquity to be inserted into the back of the femur from immediately below the insertion of the quadratus femoris down to the linea aspera. (They are sometimes separated from the rest to form an "adductor minimus.") The middle fibres pass into the whole length of the linea aspera and a small part of the medial supracondylar line, while the posterior (ischial) fibres run vertically downwards to end in a round tendon, which is inserted into the "adductor tubercle" on the medial condyle of the femur. This tendon

forms the arch over the femoral vessels as they pass into the popliteal space.

The **obturator externus** can be seen above the upper border of the adductor magnus. It arises from the anterior and inferior margins of the obturator foramen and from the medial two-thirds of the outer surface of the obturator membrane. The fibres are directed laterally and backwards and end in a tendon which passes below and then behind the neck of the femur to be inserted into the digital fossa of the great trochanter, as was seen in the dissection of the buttock.

The adductor magnus and the obturator externus muscles are to be detached from their origins—in the latter case commencing at its anterior part—care being taken to preserve the two divisions of the obturator nerve. These are to be traced to the parent trunk, which is to be followed into the obturator notch, where close beside it the **obturator artery** is to be secured. The distribution of this vessel on the surface of the **obturator membrane** will be exposed by completing the reflection of the obturator externus muscle.

The **obturator artery** enters the thigh from the pelvis in company with the obturator nerve through the upper part of the obturator foramen. It divides at once into two branches which run in opposite directions to form an arterial circle on the obturator membrane under cover of the obturator externus muscle. Branches are given off to the neighbouring muscles, and the lateral branch sends a twig to the hip joint which enters through the cotyloid notch of the acetabulum.

THE HIP JOINT

The anterior part of the capsule of the joint is to be exposed by reflecting the psoas and iliacus, and removing any remains of the pectineus. Under the ilio-psoas tendon a bursa will be displayed which facilitates the play of the tendon over the joint. In some cases it will be found to communicate directly with the cavity of the joint through an opening in the capsule. The reflected head of the rectus femoris and the tendon of the gluteus minimus, already noted to be more or less incorporated with the lateral part of the capsule, are to be removed. The tensor fasciæ femoris and the ilio-tibial band have also to be reflected. The student will remember that in close relation with the posterior part of the capsule there were the pyriformis, obturator internus, and gemelli, so that the only part of the capsule which is unsupported by muscles is the postero-inferior part. This fact is of considerable surgical importance, as it is through this part of the capsule that the head of the femur erupts in dislocation of the hip joint. The **articular capsule** is now to be thoroughly cleaned, so that the direction and incidence of its fibres may be fully displayed.

The superior attachment of the **articular capsule** is more or less along the acetabular margin, but it extends somewhat beyond it at the attachments of the capsular bands. Inferiorly the capsule surrounds the neck of the femur, and its fibres are firmly fixed along the intertrochanteric line in front; behind, however, it crosses about the middle of the neck, and is there only feebly attached to the bone. The capsule consists of two sets of fibres, a superficial longitudinal set and a deeper set running more or less circularly, and only to be seen on the surface on the posterior aspect. The longitudinal fibres at certain parts of the capsule form thickened bands, with more or less definite attachments, and termed "capsular ligaments." The **ilio-femoral** (Fig. 38) is the strongest of these,

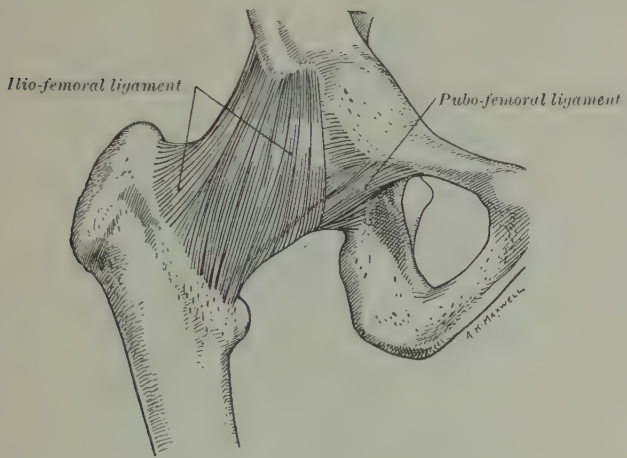


FIG. 38.

The capsule of the hip joint from the front. (After Quain.)

and arises from the anterior inferior iliac spine. It divides below into two parts, which are attached to the upper and lower ends of the anterior intertrochanteric line, and between them the capsule is thin. The band resembles, therefore, an inverted Λ, and is sometimes termed "the Y-shaped ligament" (of Bigelow). The **pubo-femoral** band (Fig. 38) springs from the pubis medial to the acetabular margin, and is attached below just above the lesser trochanter, blending there with the medial part of the ilio-femoral band. The **ischio-femoral** band (Fig. 39) runs from the back of the ischium above the tuberosity in rather a spiral manner over the back and top of the capsule to the anterior angle of the great trochanter. The portions of the capsule between these three bands are relatively thin.

The **zonular** band is formed by the circular fibres of the capsule. It encircles the neck of the femur; posteriorly, it is visible on the surface, below the ischio-femoral ligament; anteriorly, however, where it will be seen on the interior of the capsule, its fibres are collected together in a rounded bundle related to the distal part of the femoral neck.

The joint is now to be opened by a transverse incision through

the anterior part of the capsule, by which means the great thickness of the ilio-femoral ligament will be demonstrated. The posterior part of the capsule is also to be cut through. The head of the femur is then to be induced out of the acetabulum as far as the remaining connecting band—the **ligamentum teres**—will allow, and the student will note from the position of the bones that this ligament would be torn in a dislocation of the joint.

The **ligamentum teres** varies considerably in size. It is attached, at

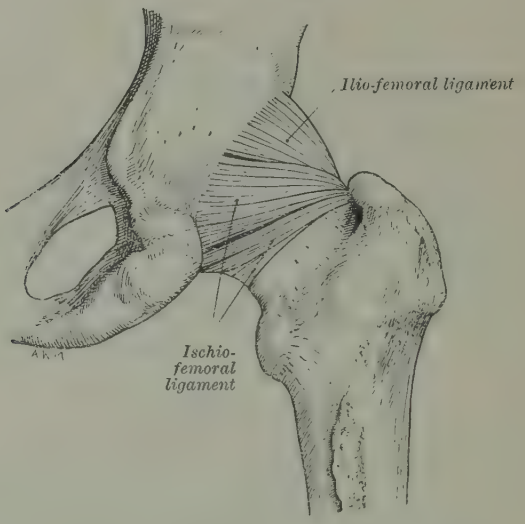


FIG. 39.

The capsule of the hip joint from behind. (After Quain.)

the one end, by two limbs to the bony margins of the cotyloid notch in the lower part of the acetabulum, and at the other to the upper part of the teres fossa on the head of the femur. It is surrounded by synovial membrane in its passage through the joint.

The ligamentum teres is to be divided, and the limb removed from the trunk, by cutting through the sciatic nerves and the hamstring muscles at their origins. The femoral part of the capsule is to be opened up by an anterior longitudinal incision so as to display the zonular band. The **retinacula** (of Weitbrecht), longitudinal ridges of synovial-covered reflections of the capsule, will be exposed on the upper and lower surfaces of the neck of the femur. They contain blood vessels passing to the intracapsular

part of the femur. The acetabulum is then to be examined, its **cotyloid** and **transverse** ligaments are to be cleaned, and the blood vessels entering its interior are to be dissected from the pad of fat which occupies its non-articular part.

The **cotyloid ligament** (or lip) is the fibro-cartilaginous ring which is firmly fixed to the bony margin of the acetabulum and to the transverse ligament, where the bone is deficient, thus bridging across the acetabular

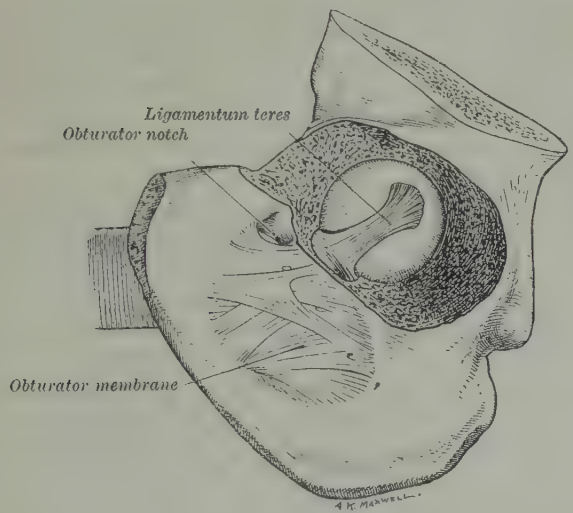


FIG. 40.

The ligamentum teres. (The acetabulum has been opened from the pelvic aspect, and the ligament displayed.)

gap. Both its free surfaces are covered by synovial membrane, and the inner fits closely against the head of the femur.

The **transverse ligament** of the acetabulum consists of fibres which bridge across the acetabular notch, blending with the cotyloid ligament above, and giving attachment superficially to part of the articular capsule. The fibres of the ligament are attached to the margins of the notch, but do not completely fill the gap, for a narrow slit-like foramen is left below between the ligament and the bone, and transmits the vessels and nerves into the joint.

THE POPLITEAL SPACE

In order that its boundaries may be maintained in position, the dissection of the popliteal space should be carried out before the dissection of the back of the thigh.

The popliteal space—or the "ham"—is a deep intermuscular cleft between the lower parts of the hamstring muscles, situated behind, and extending some distance above and below the knee joint. It contains the continuations downwards from the thigh of the blood vessels and nerves which supply the leg and the foot.

Surface Anatomy.—On the lateral side of the space the tendon of the **biceps** can readily be distinguished and traced downwards to its insertion on the head of the fibula. Immediately to the medial side of the tendon, and lying close to the fibula, the **lateral popliteal** (or common peroneal) nerve may be felt and rolled on the underlying bone. The cord-like tendon of the **semi-tendinosus**, and deep to it the flatter tendon of the **semi-membranosus**, can easily be distinguished on the medial side of the space, and followed to their attachments on the tibia. By flexing the knee, and pressing very deeply between the hamstrings, it may be possible to palpate the **popliteal artery**.

A medial vertical incision extending four inches above and the same distance below the bend of the knee is to be made through the skin covering the space. At its extremities, transverse incisions should be made the whole breadth of the limb, and the flaps of skin thus defined should be reflected. In the superficial fascia over the upper part of the area exposed, a few twigs of the **small sciatic** nerve (Fig. 30) may be secured near the middle line, while the terminal branch of that trunk pierces the deep fascia just below the line of the knee joint and is distributed to the skin of the upper part of the calf. It lies close beside the **short saphenous** vein, which ascends in the middle line of the leg, and is to be traced upwards through the lower part of the space till it disappears through the deep fascia.

The superficial fascia is then to be removed, leaving intact the nerves and the vein secured, so that the deep fascia is exposed. This layer, continuous with the fascia lata above, is of considerable strength, and protects the nerves and vessels which lie beneath it. It is firmly attached on each side to the tendons of the hamstring muscles, from which it receives accessions of fibres.

The deep fascia is to be incised in the middle line and reflected, thereby exposing the loose fat which fills the space and in which the vessels and nerves are embedded. The **lateral popliteal** nerve should be secured first, close to the medial side of the tendon of the **biceps**; and in the middle line the **medial popliteal** nerve, a larger trunk, is to be isolated from the surrounding fat. These nerves are to be traced upwards and downwards, and care taken to preserve their **communicating** branches, **fibularis** and **tibialis** respectively, which converge as they pass downwards on to the surface of the

gastrocnemius muscle. The muscles bounding the space are then to be cleaned and separated from one another, so that the popliteal nerve trunks may be followed in their whole course and their cutaneous and muscular branches dissected out.

The upper part of the popliteal space (Fig. 41) is bounded by the diverging hamstring muscles, the biceps on the lateral side and the semi-tendinosus and semi-membranosus on the medial. Deep to the medial hamstrings the posterior surface of the **adductor magnus** muscle and its tendon will be seen. These should be carefully cleaned, and the opening between the muscle and the tendon of the adductor through which the popliteal artery enters the popliteal space from the adductor canal of the thigh is to be defined. The lower boundaries of the space are the lateral and medial heads of the **gastrocnemius**, which are attached above to the condyles of the femur. Below the medial head a bursa should be looked for, and deep to the lateral head the small fleshy belly of the **plantaris** is to be found. The heads of the gastrocnemius should be separated widely with the handle of the knife, so that the **popliteus** and the upper border of the **soleus** muscle are exposed in the interval between them.

The **lateral popliteal** (or **common peroneal**) **nerve** (Fig. 41) is the smaller of the two terminal branches into which the great sciatic nerve divides about the middle of the thigh. It lies altogether under cover of the biceps muscle, the tendon of which it closely follows to the fibula, crossing in its course the lateral head of the gastrocnemius. It leaves the popliteal space by winding round the neck of the fibula and entering the peroneus longus muscle, in which it divides into its terminal branches —the anterior tibial and the musculo-cutaneous nerves. Its communicans fibularis branch has already been secured, and will afterwards be found to join the communicans tibialis to form the short saphenous nerve. A second cutaneous branch, the lateral cutaneous nerve of the calf, arises from the popliteal nerve itself, or more frequently from its communicans branch. The lateral popliteal nerve also gives off articular branches to the knee joint, small in size and difficult to secure ; two of them accompany the lateral articular branches of the popliteal artery, and a third (to be secured later) runs with the recurrent branch of the anterior tibial artery.

The **medial popliteal** (or **tibial**) **nerve** (Fig. 41), the other branch of the great sciatic, enters the popliteal space from under the biceps muscle. It runs vertically through the space immediately underneath the deep fascia, passes between and below the heads of the gastrocnemius, and then under the upper margin of the soleus into the back of the leg. Its cutaneous branch, the nervus communicans tibialis, has already been secured and traced downwards superficial to the gastrocnemius. Its numerous muscular branches arise close together in the lower part of the space, and enter both heads of the gastrocnemius, the soleus, plantaris, and popliteus muscles. (The branch to the popliteus cannot be completely followed out at present, but should be traced as far as the lower border of the muscle.) The articular branches of the nerve, three in

number, accompany the azygos and the medial articular branches of the popliteal artery—that accompanying the inferior medial vessel usually

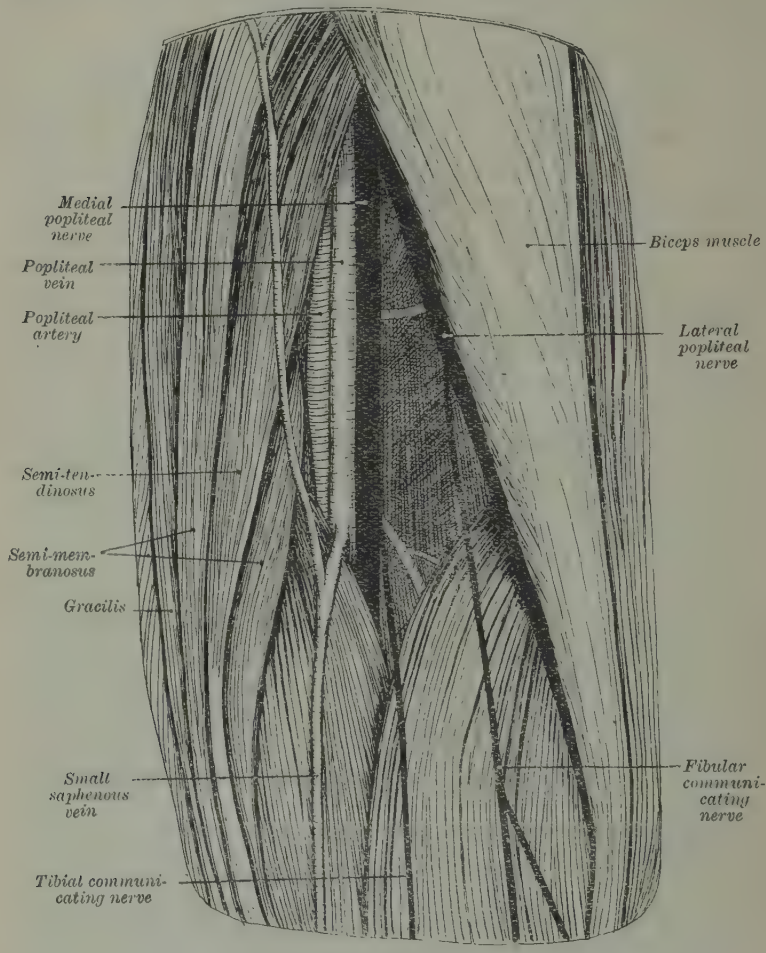


FIG. 41.

Dissection of the popliteal space.

being large enough to be easily found along the upper border of the popliteus muscle.

The **popliteal artery** and **vein**, the artery lying deep to the vein, are now to be cleaned, and the remaining fat is to be removed

from the popliteal space so as to expose the structures which form its floor. In doing this, care is required to preserve the **articular** branches of the popliteal artery which lie in close contact with the floor. The **superior articular** vessels, **medial** and **lateral**, wind round the femur just above its condyles; the **azygos** branch pierces the posterior ligament of the knee joint; and the **inferior** vessels will be found in the lower part of the space in relation to the popliteus muscle. Lying on the medial edge of the popliteal artery, the branch of the **obturator nerve** to knee joint should be sought; it emerges from the adductor magnus muscle and enters the joint through the posterior ligament. The short saphenous vein is to be followed till it enters the popliteal vein, and a few **lymphatic glands** which lie in the fat round the artery are to be sought.

The **popliteal vein** (Fig. 41) is formed by the junction of the anterior and posterior tibial veins at the lower border of the popliteus muscle. In its passage through the popliteal space it lies superficial to the artery, to which it is closely adherent. It is rather to the medial side of that vessel in the lower part, but crosses to its lateral side in the upper part of the space. It enters the adductor canal of the front of the thigh through the opening in the adductor magnus muscle, and there becomes the femoral vein. Its branches correspond more or less to the branches of the popliteal artery, and in addition the short saphenous vein has been seen to join it.

The **popliteal artery** (Figs. 41 and 42) is the continuation of the femoral artery. It commences, therefore, at the opening in the adductor magnus, and it extends to the lower border of the popliteus muscle where it divides into anterior and posterior tibial arteries. In its course through the space it is separated from the back of the femur by a layer of fat about a quarter of an inch in thickness, but below, it is in direct contact with the posterior ligament of the knee joint, and lower down with the fascia covering the popliteus muscle. Its vein is superficial to it throughout, lying to its lateral side above and slightly to its medial side below. The medial popliteal nerve is still more superficial, and in a downward direction also crosses the artery from the lateral to the medial side. At its commencement the popliteal artery is on the medial side of the space and under cover of the semi-membranosus, but in the middle part of its course, in the interval between the femoral condyles, it is uncovered by muscles. This part of the vessel is short, as it soon passes beneath the gastrocnemius and plantaris muscles, and its termination is under cover of the upper border of the soleus.

The **branches** of the popliteal artery are: (1) The **superior muscular** branches from the upper part of the vessel, which are distributed to the adjacent hamstring muscles, and anastomose with the lower perforating branches of the profunda. (2) The **articular** branches are five in number, viz., two superior, two inferior, and one azygos or median vessel. The **superior** arteries, medial and lateral, arise just above the condyles of the femur, and wind horizontally round the bone to the front of the knee joint to supply it. They anastomose with one another, with the lower articular branches, and with the anastomotica magna branch of the femoral artery. The lateral vessel runs beneath the tendon of the biceps, while

the medial proceeds under cover of the medial hamstrings and the tendon of the adductor magnus, and reaches the deep surface of the vastus medialis. The **inferior** arteries arise from the popliteal at the upper border of the popliteus muscle. The lateral branch passes horizontally under cover of the plantaris and lateral head of the gastrocnemius, and reaches the front of the knee joint after passing deep to its fibular collateral ligament. The medial vessel passes downwards and medialwards along the upper border

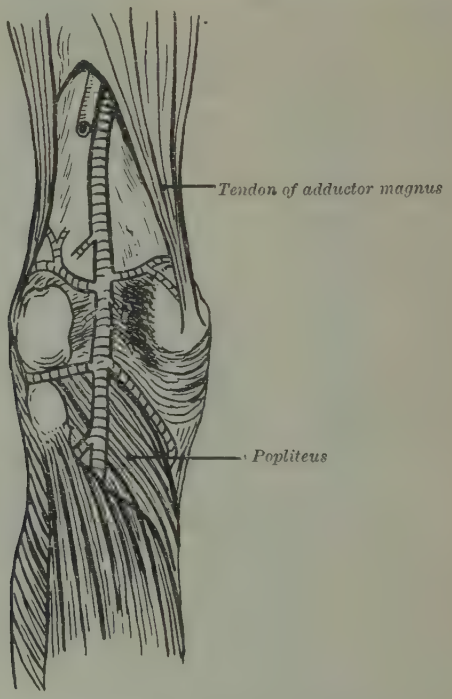


FIG. 42.

The popliteal artery and its branches. (The azygos branch is not shown.)

of the popliteus muscle, and turns forwards to the front of the joint under cover of the tibial collateral ligament. The **azygos** articular artery arises from the popliteal as it lies on the posterior ligament of the knee joint. It pierces that ligament, with the articular branch of the obturator nerve, and supplies the synovial membrane and the ligaments in the interior of the joint. (3) The **inferior muscular**, or **sural**, branches are distributed to the upper parts of the gastrocnemius and soleus, and to the plantaris muscle.

The popliteal vessels and nerves are now to be hooked to the medial side, so that the **floor of the space** may be thoroughly

exposed. The popliteal surface of the femur forms its upper part, then the posterior ligament of the knee joint, and below this the popliteus muscle covered by a dense fascia. These latter structures will be studied later, when they are more freely exposed.

THE BACK OF THE THIGH (The Flexor Region)

The skin left on the back of the thigh is to be removed, and some twigs of the **small sciatic** nerve are to be found in the superficial fascia. The nerve itself is seen when the deep fascia (fascia lata) is reflected, after which the hamstring muscles are to be cleaned and the **great sciatic** nerve followed downwards in relation to them. The branches of this nerve to the hamstrings, as also another which assists in the supply of the **adductor magnus**, are to be secured, and its terminal division into the medial and lateral popliteal trunks is to be defined.

The term "hamstring" muscles is applied to the three flexor muscles on the back of the thigh. They take origin, as was seen in the dissection of the buttock, from the tuberosity of the ischium, and stretch below, as the boundaries of the popliteal space, to the upper ends of the tibia and fibula. The **biceps**, the lateral muscle, has its second head of origin on the lower part of the femur, and this joins the ischial, or long head, on its medial side.

The **biceps** (Fig. 43) arises by a long head from the lower and medial part of the tuber ischii, in common with the semi-tendinosus, and its superficial fibres are in direct continuity with those of the sacro-tuberous ligament. It crosses the great sciatic nerve, and, diverging from the medial hamstrings in the lowest fourth of the thigh, forms the lateral boundary of the popliteal space. The short head arises from the lateral lip of the linea aspera and lateral supracondylar ridge down to within two inches of the femoral condyle, and from the lateral intermuscular septum. The two heads unite opposite the lower end of the femur, and the tendon of the muscle is inserted into the bicipital tuberosity on the head of the fibula. The tendon is split into two at its insertion by the lower end of the fibular collateral ligament, and from its parts aponeurotic expansions pass backwards to the deep fascia of the leg and forwards to the lateral condyle of the tibia.

The **semi-tendinosus** (Fig. 43) arises in common with the long head of the biceps from the tuber ischii. It lies on the semi-membranosus throughout its course, and with it forms the medial boundary of the upper part of the popliteal space. The muscle ends in a round tendon in the lower third of the thigh, and this turns forwards below the knee to be inserted into the tibia below its medial condyle. From the lower border of the tendon fibres are given to the deep fascia of the leg, and its upper border is adherent to the tendon of the gracilis which is inserted immediately above it. Both of these tendons, gracilis and semi-tendinosus, are under cover of the expanded insertion of the sartorius. The muscular

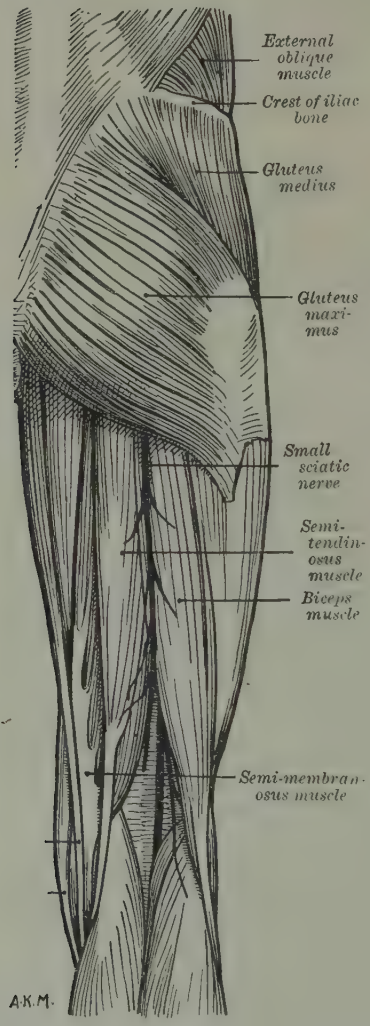


FIG. 43.

The muscles of the back of the thigh.

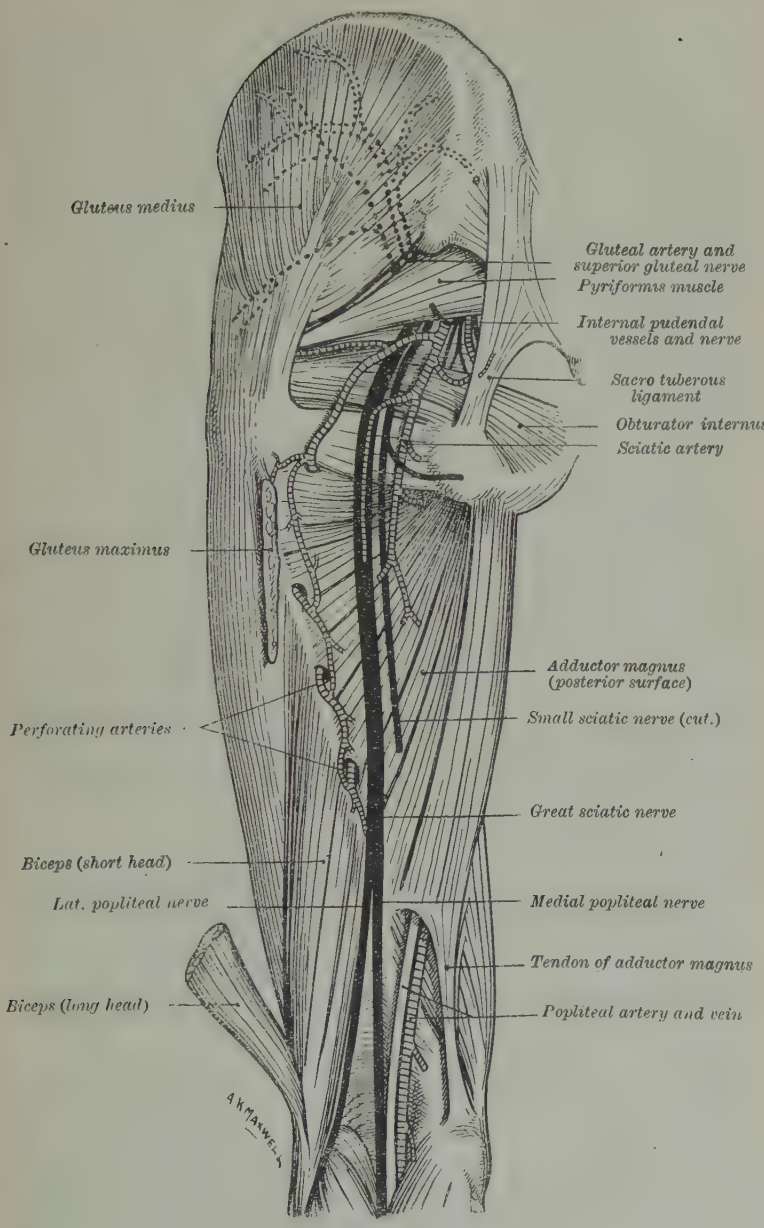


FIG. 44.

Deep dissection of the back of the thigh.

fibres of the semi-tendinosus are crossed by a tendinous intersection at about the middle of the thigh.

The **semi-membranosus** (Fig. 43) is at first lateral to the biceps, its tendon of origin being attached to the lateral and upper part of the tuberosity of the ischium. This tendon then passes beneath the origin of the biceps and semi-tendinosus, and from it the muscular fibres arise and form a thick belly which extends almost to the knee. It is inserted by a short strong tendon into a horizontal groove on the posterior surface of the medial condyle of the tibia, under cover of the tibial collateral ligament. Two other attachments are effected through aponeurotic expansions of the tendon, one running upwards and lateralwards and forming the oblique band of the posterior ligament of the knee joint, and the other forming a fascial covering to the popliteus muscle.

The **great sciatic nerve** (Fig. 44), continued from the buttock, lies on the posterior surface of the adductor magnus after leaving the quadratus femoris. It passes beneath the long head of the biceps, and lies under cover of that muscle till at a variable point, but generally about the middle of the thigh it divides into the medial and lateral popliteal trunks, which have already been traced. It supplies branches to the three hamstring muscles, and a branch to the adductor magnus.

The posterior surface of the adductor magnus should be fully exposed by throwing downwards the hamstring muscles (Fig. 44). The terminations of the **perforating branches** of the profunda femoris artery are to be secured close to the linea aspera of the femur. (Four vessels, however, are not always to be found, sometimes only one may be present.) These vessels lie directly on the bone, and are covered over by tendinous arches in the insertion of the adductor muscle. The osteo-tendinous passages are to be carefully defined, and they will be seen to be in series with the larger opening through which the femoral artery passes to become the popliteal. They serve to protect the vessels from the effects of the contraction of the muscle.

The **perforating arteries** (Fig. 44), after emerging from the tendinous arches, wind round the back of the femur, and having given off branches to the hamstring muscles, enter the vastus lateralis. The lower members of the series pierce the short head of the biceps. In a well injected limb, the four vessels will be seen to form a longitudinal chain of anastomoses in the back of the thigh, and this communicates above with the sciatic and medial femoral circumflex arteries, and below with the superior muscular branches of the popliteal.

THE DISSECTION OF THE LEG AND DORSUM OF FOOT

Surface Anatomy. — The medial surface of the **tibia** below the insertion of the sartorius is subcutaneous, and its anterior and medial borders can be followed throughout their whole length. The head of the **fibula** is easily distinguished at its articulation with the back of the lateral condyle of the tibia, but the upper half of

its shaft cannot be felt from the surface, since it is covered by the **peroneal** muscles; the lower part of the shaft, however, is subcutaneous, and may be followed to the malleolus. The two **malleoli** should be carefully palpated, and it will be noted that the medial is the broader and more prominent, but does not descend so far as the lateral. Immediately above the heel the **tendo Achillis** can be felt. The individual tarsal bones cannot be distinguished by palpation from the dorsum of the foot, but on its medial margin, about one inch below the medial malleolus, the **sustentaculum tali** can be felt, and about an inch in front of this the tuberosity of the

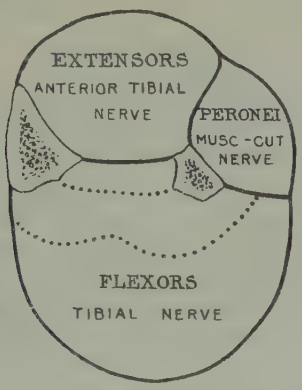


FIG. 45.

Transverse section of leg to show muscular compartments.

navicular bone. The lateral surface of the **calcaneus** is almost entirely subcutaneous, and if it is well developed, the **peroneal tubercle** can be felt on it about an inch below the tip of the lateral malleolus. The head of the **astragalus** can be distinguished as a slight prominence on the dorsum of the foot between the malleoli, if the foot is strongly ventriflexed.

In the dissection of the leg it is convenient to recognise four regions (Fig. 45). 1. A **tibial** region, corresponding to the medial surface of the shaft of the tibia. 2. An **anterior tibio-fibular** region, comprising the interval between the bones of the leg and in front of the interosseous membrane, and containing the extensor muscles. 3. A **peroneal** compartment, in which, related to the lateral surface of the **fibula**, lie the peroneal muscles. 4. A **posterior tibio-fibular** region, placed between and behind the bones of the

leg, and posterior to the interosseous membrane, and containing the flexor muscles of the foot and toes.

A block is to be placed under the knee, and the limb arranged with the heel on the table. An incision is to be made along the anterior border of the tibia from the knee to the ankle, and thence along the centre of the dorsum of the foot to the roots of the toes. A transverse incision is to be made across the ankle reaching the malleoli, and a second incision across the foot at the bases of the toes. The flaps of skin thus marked out are to be reflected to the margins of the limb, care being taken to leave intact on the dorsum of the foot the cutaneous nerves. The **tibial** region is to be examined first.

TIBIAL REGION

In the superficial fascia of this region, the **long saphenous vein** is to be found crossing over the lower third of the tibial surface. It arises from the medial end of a **venous arch** on the dorsum of the foot, and is to be traced upwards from in front of the medial malleolus, thence across the tibia and upwards behind its medial border to the back of the medial side of the knee, from which point it was traced in the dissection of the thigh. Immediately behind the lower part of the vein, the **long saphenous nerve** is to be secured, and its continuity established into the thigh. It gives off cutaneous twigs to the lower part of the leg, and it may with care be traced half-way along the medial side of the foot. The superficial fascia should then be cleared from the surface of the tibia, preserving, however, the nerve and vein, and the precise insertions of the **sartorius**, **gracilis**, and **semi-tendinosus** into its upper part are to be defined. The tendons are more or less united with one another, but it is easily determined that the sartorius is inserted most anteriorly, and overlaps the gracilis and semi-tendinosus, the former lying above the latter. These tendons being displaced, a bursa will be found between them and the **tibial collateral ligament** of the knee joint, which will be exposed.

ANTERIOR TIBIO-FIBULAR REGION AND DORSUM OF FOOT

The **superficial veins** of the foot and toes form a venous arch across the dorsum of the foot, from the medial end of which the long saphenous vein has already been traced. From its lateral end the **short saphenous** vein arises, and is to be traced upwards to behind the lateral malleolus. It is accompanied by the **short**

saphenous nerve which is to be followed to the lateral side of the little toe.

The **lateral cutaneous nerve of the calf** is to be traced from the lateral popliteal nerve into the upper and lateral part of the leg, and below it, in the lower third of the leg, the **cutaneous** division of the **musculo-cutaneous** nerve is to be secured as it emerges from the deep fascia, and is to be followed downwards to the toes. The terminal **cutaneous** branch of the **anterior tibial** nerve pierces the deep fascia on the dorsum of the foot in the interval between the first and second metacarpal bones, and is distributed to the adjacent sides of the great and second toes.

The skin is to be removed from the toes through a medial incision in each, and the **dorsal digital nerves** are to be examined.

The **cutaneous** division of the **musculo-cutaneous** (superficial peroneal) **nerve** (Fig. 47) pierces the deep fascia in the lower third of the leg lateral to the middle line, and at once divides into two branches. The medial branch gives small twigs to the medial side of the ankle and foot, and then divides to form the dorsal digital nerves of the medial side of the great toe and of the adjacent sides of the second and third toes. The lateral branch crosses the dorsum of the foot, to the skin of which it supplies small twigs, and then divides to form the digital nerves of the adjacent sides of the third and fourth and fourth and small toes.

The **dorsal digital nerves** (Fig. 47) of the adjacent sides of the great and second toes are derived from the terminal cutaneous branch of the anterior tibial nerve, and that of the lateral side of the little toe is the short saphenous nerve.

The distribution of the musculo-cutaneous nerve is often diminished on the lateral side of the foot, in which case it will be found to be replaced by the short saphenous nerve.

The superficial fascia of the leg should now be removed and the **deep fascia** is to be cleaned. In the upper part of the leg this layer is dense and white, due to the fact that here it gives origin to the underlying muscles; but it thins as it is traced downwards and on the dorsum of the foot it is exceedingly fine. In the region of the ankle joint, however, and covering the muscle tendons at the position of a change in their direction, it is thickened in the form of two bands, the **anterior** and the **lateral annular ligaments**, which should now be examined.

The **anterior annular ligament** (Fig. 46) consists of two parts. The upper of these passes across the front of the leg immediately above the ankle, and is attached by its extremities to the tibia and fibula. The lower part is narrow, but well defined, laterally, and is there attached to the anterior end of the calcaneus, but as it passes over the front of the ankle joint it divides into two less distinct diverging bands; of these the upper reaches the medial malleolus and the lower passes to the medial tarsal bones.

The **lateral annular ligament** passes between the lateral malleolus and the posterior part of the lateral surface of the calcaneus.

The division of the leg into the four regions previously mentioned is indicated by the attachments of the **deep fascia** and of the intermuscular septa given off from its deep surface. The deep fascia is absent over the medial subcutaneous surface of the tibia, being attached to the anterior and medial borders of that bone, but otherwise forms a complete investment for the leg. As it lies over the fibular region, two strong septa proceed from it to be attached to the anterior and lateral borders of the fibula, and enclosing the peroneal region separate it from the anterior and the posterior tibio-fibular compartments.

The deep fascia is now to be removed from the front of the leg, and in doing so it is best to begin from below and work upwards. The borders of the two parts of the anterior annular ligament should be defined artificially with the knife, so that these bands may be isolated and left in position. Above them, the fascia is easily removed, a medial longitudinal incision being made in it and its flaps turned medially and laterally, to display respectively its attachment to the anterior border of the tibia and the anterior peroneal septum. In the upper part of the leg, however, it is impossible to remove the fascia from the underlying muscles, and it should be allowed to remain on their surface. The four **extensor muscles** displayed by this dissection are now to be cleaned, and their tendons followed on to the dorsum of the foot to their insertions. Two of them extend the whole length of the leg, the **tibialis anterior** in relation to the tibia, and the **extensor digitorum longus** in relation to the fibula. The **peroneus tertius** is in most cases continuous with the lower and lateral part of the extensor digitorum muscle, but their respective tendons are easily distinguished; and appearing from between the two long muscles in the lower part of the leg is the tendon of the **extensor hallucis longus.**

The **tibialis anterior** (Fig. 46) arises from the upper half of the lateral surface of the shaft of the tibia, from the fascia which covers it, and from the interosseous membrane on which it rests. In the lower third of the leg the muscle fibres end in a tendon, and this reaches the dorsum of the foot by passing through both parts of the anterior annular ligament, which split so as to enclose it. The tendon then turns round the medial margin of the foot, and is inserted into the under surface of the first cuneiform bone and the adjacent part of the base of the first metatarsal bone. The tendon and the compartments of the anterior annular ligament through which it passes are lined by synovial sacs.

The **extensor digitorum longus** (Fig. 46) arises from the upper three-fourths of the anterior surface of the shaft of the fibula, and from the lateral condyle of the tibia close to the tibialis anterior. It also derives fibres from the investing fascia and from the interosseous membrane. The tendon of the muscle begins just above the ankle, and passes under

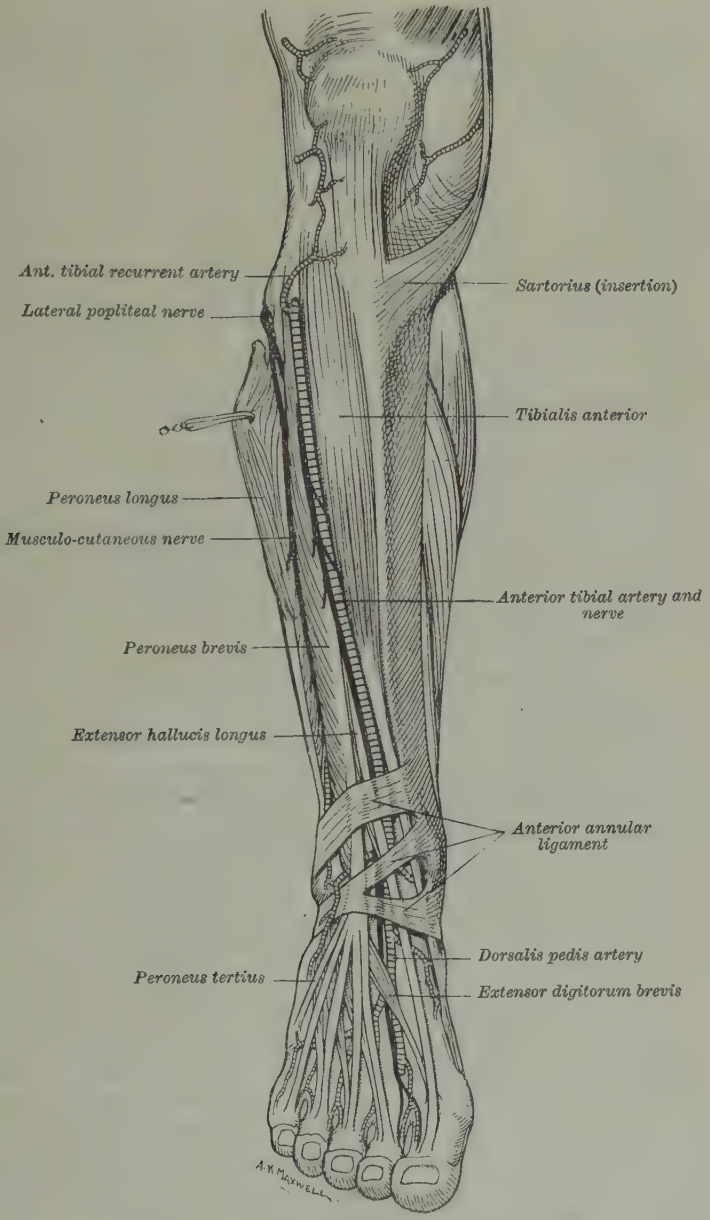


FIG. 46.

Dissection of the anterior tibio-fibular region and dorsum of the foot. (The anterior tibial artery and nerve are represented as if superficially placed in their upper parts, and the peroneus longus is dissected to expose the lateral popliteal nerve.)

the upper part, but through a synovial lined compartment of the lower part of the anterior annular ligament. It at once divides into four slips which diverge from each other as they cross the dorsum of the foot to reach the four lateral toes. Each slip forms an expansion on the dorsum of the first phalanx, and this is joined by the corresponding interossei muscles, but seldom by the appropriate lumbricalis, as is the case in the hand. The tendons of the second, third, and fourth toes are also joined by a tendon of the extensor digitorum brevis, which lies beneath. The expansion then more or less divides into three slips, the central of which is inserted into the base of the second phalanx, and the lateral, uniting with each other, reach the base of the third phalanx.

The origin of the **peroneus tertius** (Fig. 46) is in continuity with that of the extensor digitorum longus, its attachments being to the lowest fourth of the anterior surface of the fibula, and to a corresponding extent of the interosseous membrane. Its tendon accompanies that of the extensor digitorum muscle deep to the upper part and through the same compartment in the lower part of the anterior annular ligament, and is inserted into the upper surface of the base of the fifth (often the fourth) metatarsal bone.

The **extensor hallucis longus** (Fig. 46) takes origin from the fibula under cover of the extensor digitorum longus, so that the upper part of the muscle is hidden from view. It arises from the middle two-thirds of the anterior surface of the fibula medially to the extensor digitorum longus, and from the adjacent part of the interosseous membrane. Its tendon passes beneath the annular ligament and crosses the anterior tibial vessels and nerve, and, on the dorsum of the foot, the insertion of the most medial tendon of the extensor digitorum brevis. It is inserted into the base of the terminal phalanx of the great toe.

The **anterior tibial vessels** and **nerve** lie on the surface of the interosseous membrane, and are to be exposed in their whole course on the front of the leg by separating the extensor muscles from one another. Commence from below, where the artery is comparatively superficial, by separating the tendons of the extensor hallucis and tibialis anterior, and follow the vessel upwards in the interval between the latter muscle and the extensor digitorum longus. It is there deeply placed, but is to be followed upwards till it is seen perforating the interosseus membrane from behind. The accompanying nerve will be found on the lateral side of the artery, and is to be traced upwards to its point of emergence from the substance of the extensor digitorum longus. Its branches to the four muscles of the anterior tibio-fibular region of the leg are to be secured, and its terminal division into medial and lateral branches on the dorsum of the foot is to be defined. The **perforating branch** of the **peroneal artery** will be found by displacing the peroneus tertius muscle. It appears through the lower part of the interosseous membrane, and descends on the lower end of the fibula to the neighbourhood of the lateral malleolus, where it anastomoses with the lateral malleolar branch of the anterior tibial.

The **anterior tibial artery** (Fig. 46) is the smaller of the terminal branches of the popliteal. It commences therefore on the back of the leg, at the lower border of the popliteus muscle, and reaches the anterior tibio-fibular compartment by piercing the interosseous membrane. It appears just below the lateral condyle of the tibia. It descends upon the interosseous membrane, at first between the tibialis anterior and the extensor digitorum longus, and then between the tibialis anterior and extensor hallucis longus. In the lower part of the leg it winds on to the tibia, and is comparatively superficial, being overlapped from the lateral side by the tendon of the extensor hallucis. It then passes beneath the annular ligament, and is crossed by the extensor hallucis near the level of the ankle joint. Its continuation upon the dorsum of the foot is known as the **dorsalis pedis**.

It is accompanied throughout its course by two venæ comites, and the anterior tibial nerve is intimately related to it.

The **branches** of the artery are: 1. The **anterior tibial recurrent**, given off as soon as the vessel reaches the front of the leg. It passes upwards through the substance of the tibialis anterior to the front of the knee, where it anastomoses with the inferior articular branches of the popliteal artery. 2. **Muscular** branches to the adjacent muscles arise at various points. 3. The **malleolar** arteries, **lateral** and **medial**, take origin immediately above the ankle joint, and pass beneath the related tendons to the malleoli, in the neighbourhood of which they are distributed. The lateral branch anastomoses with the perforating peroneal and with the tarsal branch of the dorsalis pedis, while the medial inosculates with the calcaneal branches of the posterior tibial artery.

The **anterior tibial** (deep peroneal) **nerve** (Fig. 46) is one of the two terminal branches of the lateral popliteal nerve. It commences on the lateral side of the neck of the fibula in the fibres of the peroneus longus, and reaches the side of the anterior tibial artery by piercing the extensor digitorum longus. It lies to the lateral side of the artery in the upper part of the leg, in front of it about the middle, and passes to its lateral side again near the ankle. Its muscular relations are the same as those of the artery, and with it, it passes under the annular ligament on to the dorsum of the foot, where it divides into two branches. In the leg it supplies the four muscles of the compartment in which it lies. The medial terminal branch continues forwards on the dorsum of the foot on the lateral side of the dorsalis pedis artery, and having pierced the deep fascia in the first intermetatarsal space, is distributed as the dorsal digital nerves of the adjacent sides of the great and second toes. The lateral branch turns laterally under cover of the extensor digitorum brevis, to which muscle and to the articulations in the neighbourhood it is distributed. There is a gangliform swelling of its sheath at its termination, which recalls the terminal enlargement of the dorsal interosseous nerve of the forearm.

The tendons of the long extensor muscles having been traced to their insertions, the student should now examine more precisely their relationship with the anterior annular ligament. The lower portion of the ligament is the more important, and by slitting it over the tendons it will be found to have formed three compartments by a localised division into two layers. These transmit respectively the tendon of the tibialis anterior, that of the extensor hallucis longus,

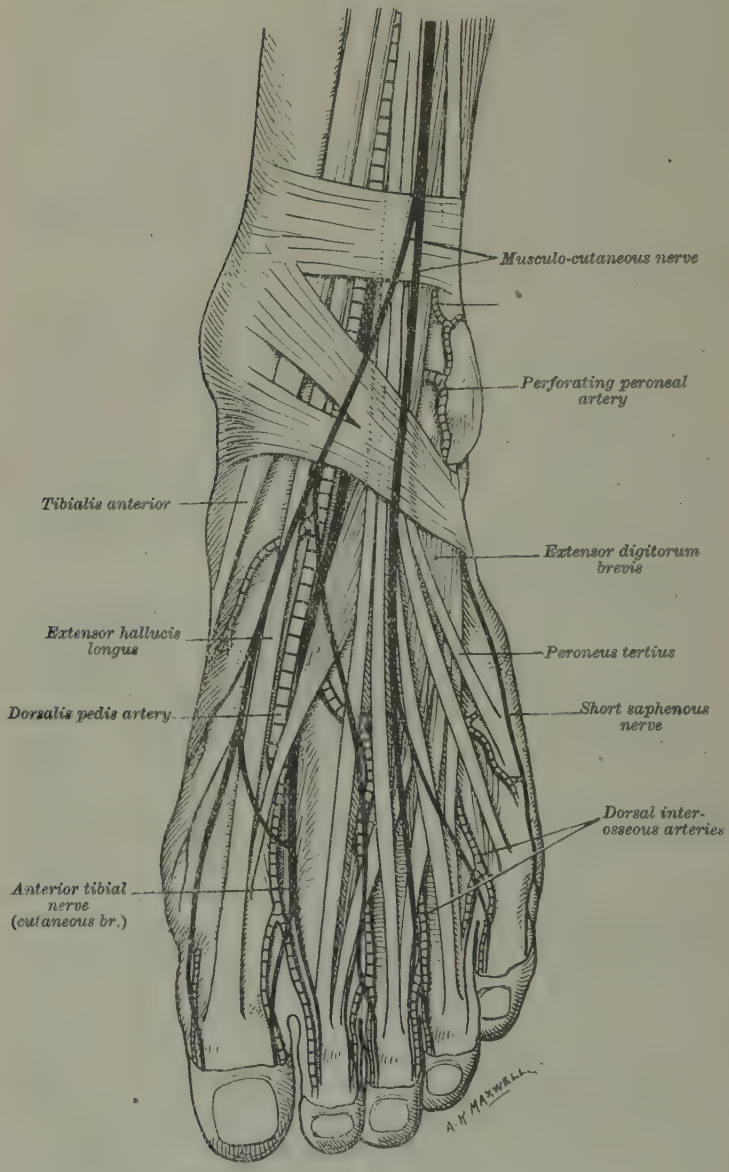


FIG. 47.

Dissection of the dorsum of the foot.

and running together in the most lateral compartment the tendons of the extensor digitorum longus and peroneus tertius. Synovial sheaths line the walls of these fibrous passages and invest the tendons, extending upwards on them some distance into the leg. The tendon of the tibialis anterior is the only one to be invested by the upper portion of the ligament, the other tendons lying wholly deep to it.

The **extensor digitorum brevis**, which lies deep to the long extensor tendons on the dorsum of the foot, is then to be dissected out. Its tendons pass forwards and medialwards to the four medial toes. The nerve to the muscle, the lateral branch of the anterior tibial, is to be secured, and the gangliform enlargement on it will be seen. The **dorsalis pedis artery**, the continuation of the anterior tibial, is to be followed forwards to its disappearance into the sole of the foot through the first intermetatarsal space, and its **tarsal** and **metatarsal** branches are to be dissected out after reflecting the extensor digitorum brevis from its origin and turning it forwards.

The **extensor digitorum brevis** (Fig. 47) arises from the anterior part of the calcaneus and from the lower border of the anterior annular ligament. It ends in four tendons. The lateral three tendons pass obliquely across the foot to the second, third, and fourth toes, and join the expansion of the corresponding tendons of the long extensor. The most medial slip crosses the dorsal artery of the foot near its termination, and is inserted directly on the dorsal aspect of the base of the first phalanx of the great toe.

The **dorsalis pedis artery** (Fig. 47) is the continuation of the anterior tibial. It commences in front of the ankle joint at a point midway between the malleoli, and runs to the base of the first metatarsal bone. At this level it leaves the dorsum of the foot by passing between the two heads of the first dorsal interosseous muscle, and having gained the sole of the foot, unites with the lateral plantar artery. It lies superficially in its course on the dorsum of the foot between the tendons of the extensor hallucis longus and the extensor digitorum longus, but is crossed near its termination by the most medial tendon of the extensor digitorum brevis. It rests upon the astragalus, the navicular, and the middle cuneiform bones and their dorsal ligaments. Two venæ comites accompany the vessel, and the medial terminal branch of the anterior tibial nerve runs along its lateral side.

The **branches** of the dorsalis pedis artery are: (1) A few small unnamed branches which pass to the medial margin of the foot, and anastomose with twigs of the medial plantar artery. (2) The **tarsal artery**, which arises from the lateral side of the vessel immediately below the anterior annular ligament, and crosses to the lateral side of the foot beneath the extensor digitorum brevis. It anastomoses with the lateral malleolar and the perforating peroneal vessels. (3) The **metatarsal artery**, which arises near the bases of the metatarsal bones. It also runs laterally beneath the extensor digitorum brevis, and from the arch formed by it three **dorsal interosseous** branches proceed forwards in the lateral spaces. These vessels bifurcate at the roots of the toes to supply the adjacent

sides of two of them, the most lateral giving off, in addition, the branch to the lateral side of the little toe. The anterior and posterior perforating arteries, derived from the plantar arch and its digital branches, join these interosseous arteries near respectively their origins and points of bifurcation. (4) The first **dorsal interosseous** (dorsalis hallucis), which arises just before the dorsalis pedis turns into the sole. It runs forward upon the great toe, and after giving a branch to its medial side which passes beneath the long extensor tendon, it bifurcates to supply the adjacent sides of the great and second toes.

THE PERONEAL REGION

The deep fascia of this region is to be incised vertically, and the anterior and posterior peroneal septa are to be demonstrated. The two muscles of this compartment, the **peroneus longus** and **peroneus brevis**, are only distinctly separable from one another after they have become tendinous. Their tendons should, therefore, be separated near the ankle, where the brevis, lying deep to the longus, is in contact with the bone, and they should then be traced upwards to their muscular bellies. The tendons are then to be followed behind the lateral malleolus and under the **lateral annular ligament** on to the lateral surface of the calcaneus, where, diverging from one another, the longus passes into the sole of the foot and the brevis to its insertion on the base of the fifth metatarsal bone.

The **peroneus longus** (Fig. 46) arises from the head and upper two-thirds of the lateral surface of the shaft of the fibula. At some distance above the ankle the muscle fibres end in a tendon, which covers that of the brevis, and passes behind the lateral malleolus and under the lateral annular ligament. It then runs across the lateral surface of the calcaneus, below the peroneal tubercle, and gains the groove on the under surface of the cuboid bone which conducts it into the sole of the foot. It is there invested by a fibrous sheath lined by synovial membrane, and is inserted into the base of the first metatarsal and the adjacent part of the medial cuneiform bone.

The **peroneus brevis** (Fig. 46) lies beneath the peroneus longus. It arises from the lower two-thirds of the lateral surface of the fibula, its upper part being in front of the lower part of the origin of the peroneus longus. Its tendon rests upon the lower part of the fibula, and winds behind the lateral malleolus, where it is lodged in a groove, and lies deep to the tendon of the peroneus longus. It then runs along the lateral side of the calcaneus, in front of the long tendon and above the peroneal tubercle, and is inserted into the most prominent part of the tuberosity at the base of the fifth metatarsal bone.

As the peroneal tendons lie in the interval between the lateral malleolus and the posterior part of the calcaneus, they are held in position by the **lateral annular ligament**—a strong band of deep fascia attached to those bony prominences. Under this ligament the tendons are invested by a common synovial sheath. On the lateral surface of the calcaneum, however, the peronei are separated by the peroneal tubercle,

and each tendon is covered by a separate fibrous sheath into each of which the common synovial membrane is continued.

The **lateral popliteal nerve** has already been traced along the medial margin of the tendon of the biceps muscle as far as the neck of the fibula. Its further course across the bone is under cover of the peroneus longus, which must be turned aside from its origin so that the nerve may be followed out. It is here that the third articular branch of the nerve to the knee joint, that running with the anterior tibial recurrent artery, is given off, and its terminal division into the **anterior tibial** and **musculo-cutaneous** nerves will be seen. The anterior tibial nerve pierces the anterior peroneal septum, and then enters the upper part of the extensor digitorum longus muscle, where it was secured in the dissection of the anterior tibio-fibular compartment. The musculo-cutaneous nerve is then to be followed downwards in the substance of the peroneus longus muscle, and its branches to both peronei are to be dissected out.

The **musculo-cutaneous** nerve (Fig. 46), from its origin from the lateral popliteal, runs downwards in the substance of the peroneus longus muscle close to the lateral surface of the fibula. It reaches the interval between the two peronei muscles, both of which it supplies, and then becomes cutaneous by piercing the deep fascia in the lower third of the leg in the interval between the peroneus longus and the extensor digitorum longus. Its further course as a cutaneous nerve on the dorsum of the foot and the toes has already been described.

THE POSTERIOR TIBIO-FIBULAR REGION

The skin is to be removed from the back of the leg as far as the heel. In the superficial fascia, the **short saphenous vein** and **nerve** will be found near the middle line, and the whole course of both structures may now be followed out. The **long saphenous vein** and **nerve** are in this region in that part of their course behind the medial border of the tibia, but both have already been dissected.

The **short saphenous vein** has already been seen to arise from the lateral side of the venous arch on the dorsum of the foot. From there it passes behind the lateral malleolus, and then upwards in the superficial fascia in the middle line of the back of the leg. In the dissection of the popliteal space it was seen to pierce the deep fascia at the level of the knee joint and to join the popliteal vein.

The **short saphenous** (sural) **nerve** is formed by the fusion of the nervi communicantes tibialis and fibularis, previously secured in the popliteal space as branches, respectively, of the medial and lateral popliteal nerves. These branches pierce the deep fascia about the middle of the calf, and the nerve formed by their junction lies close to the short saphenous vein. It accompanies the vein behind the lateral malleolus, where it was previously secured and traced along the lateral side of the foot and as the dorsal digital nerve of the lateral side of the little toe.

The superficial fascia is to be removed and the deep fascia of the posterior part of the leg thus exposed. At no part is it of great strength, but at the ankle it forms the medial and lateral annular bands. In the region of the knee it receives accessions of fibres from the muscles inserted on the medial surface of the tibia, and is continuous above with the fascia of the popliteal space. It is to be incised along the centre line, and its attachment to the medial border of the tibia should be defined, while on the lateral side the posterior peroneal septum intervening between the peronei and flexor muscles is to be seen. The deep fascia, with the exception of the annular ligaments, is then to be removed, and the superficial muscles of the calf are to be dissected.

The **muscles** of the back of the leg are arranged in two groups—the superficial and the deep. The superficial group consists of three muscles. Two of them, the **gastrocnemius** and the **soleus**, are of large size, and descend, the former lying on the surface of the latter, to be inserted by a common tendon—the **tendo Achillis**—into the posterior surface of the calcaneus. The third member of the group, the **plantaris**, lies between the other two. The muscles of the deep group descend into the sole of the foot behind the medial malleolus. They are covered over by a layer of deep (sub-soleal) fascia, which stretches between the tibia and fibula, and separates the two groups of muscles (Fig. 45). Towards the ankle this layer of fascia acquires a considerable density, as may be seen by exposing it deep to the tendo Achillis, and it will be found to take a considerable part in the formation of the medial annular ligament, with the upper border of which it is continuous.

The **gastrocnemius**, the superficial muscle of the calf, arises by two heads from the back of the femur immediately above its condyles. The origin of the lateral head extends on to the lateral surface of the lateral condyle, while that of the medial head runs upwards for about an inch along the medial supracondylar ridge. The two heads swell out as they proceed downwards, and form the bellies of the muscle. These do not join one another, but are separated by a groove, at the bottom of which there appears the flattened tendon which spreads out on the deep face of the muscle, and to which the muscular fibres of both bellies are attached. This tendon is joined anteriorly and laterally by that of the soleus, and the conjoined tendon is named the **tendo Achillis**. This contracts near the heel into a thick rounded bundle, but expands again at its insertion into the middle part of the posterior surface of the calcaneus, a bursa intervening between it and the upper part of the bone.

The branches of the **medial popliteal** nerve to both bellies of the gastrocnemius are to be traced into their substance, and the **plantaris** should be isolated from the deep surface of the lateral

head. Both heads of the gastrocnemius should then be divided about two inches below their origin, and these should be turned upwards so as to define the precise positions of their femoral attachments. The lower portions being thrown distally, the **soleus** will be displayed in its whole length, and lying on its surface the long narrow tendon of the plantaris.

The **plantaris** arises from the back of the femur immediately above the lateral condyle. Its fleshy belly is only about three inches long, and lies below the medial part of the lateral head of the gastrocnemius; but its tendon is the longest in the body and very slender. It runs downwards between the gastrocnemius and soleus, crossing obliquely from the lateral to the medial side, and is inserted on the posterior surface of the calcaneus at the medial edge of, or in common with, the tendo Achillis.

The **soleus** is tendinous on its surface, and between it and the opposed tendinous surface of the gastrocnemius there is a quantity of loose areolar tissue. The muscle arises from both bones of the leg and from a strong fibrous arch between their upper parts, which covers over the posterior tibial vessels and nerve. The attachment to the tibia is along the oblique line below the insertion of the popliteus and on the middle third of the medial border of the shaft, and on the fibula it arises from the posterior surface of the head and upper third of the shaft. The muscle fibres end on the deep surface of the broad tendon which joins with that of the gastrocnemius below the middle of the leg to form the tendo Achillis.

The tendon of the plantaris is to be cut. The tendo Achillis is to be divided just below its formation and dissected closely down to its insertion, and the bursa between it and the upper part of the calcaneus will be displayed. The remaining part of the soleus is to be divided by a medial vertical incision, cutting carefully through the muscle substance till the shining tendinous expansion on the deep surface is exposed. The remarkable shortness of the fibres of the muscle will be made apparent. After exposing the tendinous arch which crosses the posterior tibial vessels and gives origin to the muscle, the two parts of the soleus are to be separated and turned medially and laterally, and dissected to their tibial and fibular origins. Branches from the medial popliteal nerve will be seen to enter the upper parts of both halves of the muscle, and lower down an additional branch is derived from the **posterior tibial** nerve. The **popliteus** muscle, covered by its fascia, will now be wholly in view, and its nerve from the medial popliteal is to be traced downwards over its surface and round its lower border. The **popliteal artery** is to be laid bare as far as the lower border of the popliteus muscle, and its division at that level into **anterior** and **posterior tibial** vessels is to be defined. The former vessel passes forwards between the tibia and fibula to the front of the leg, where it has

already been dissected, but from this part of the artery a small twig, the **posterior recurrent artery**, is usually given off. It runs upwards deep to the popliteus to the back of the knee joint. The deep fascial (sub-soleal) septum covering the deep group of muscles is now to be removed, but the medial annular ligament, with which it is continuous, is still to be left in position. The muscles exposed (Fig. 48) are the **flexor hallucis longus** in relation to the fibula, the **flexor digitorum longus** in relation to the tibia, and between these muscles, and partly covered by an aponeurotic expansion connecting them, the **tibialis posterior**. Superficial to these muscles and giving branches to each of them, the **posterior tibial nerve**, the continuation of the medial popliteal, is to be followed downwards to the ankle, where its cutaneous branch to the heel is to be secured. The **posterior tibial artery** is then to be dissected out. It gives off near its origin the **peroneal** branch, which with the parent trunk should be followed downwards with as little laceration as possible of the related flexor muscles.

The **popliteus** (Fig. 48) is covered by a strong fascia which is derived in main part, from the tendon of the semi-membranosus. When this is removed, the oblique fibres of the muscle will be exposed, and their insertion into the posterior surface of the tibia above the oblique line can be demonstrated. At this stage its nerve should be traced round its lower border on to its anterior surface. When traced upwards the muscle fibres pass into the tendon of origin which emerges from the fibrous capsule of the knee joint, within which it is attached to the popliteal groove on the lateral condyle of the femur. The intra-capsular relations of the tendon will be studied in a later dissection.

The **posterior tibial artery** (Fig. 48) appears as the direct continuation of the popliteal artery, and is the larger of its terminal divisions. It begins at the bifurcation of the parent trunk, which usually takes place at the lower border of the popliteus muscle. In the upper part of its course the posterior tibial artery lies between the superficial and deep groups of muscles of the back of the leg, but in the lower third of the leg it lies by the medial side of the tendo Achillis, and is covered only by the superficial and deep fasciæ. It rests upon the tibialis posterior for two-thirds of its length, and then on the flexor digitorum longus; but at the ankle it lies directly upon the tibia between the tendons of the flexor digitorum and flexor hallucis longus. The vessel then passes beneath the medial annular ligament, and in the interval between the medial malleolus and the heel it divides into medial and lateral plantar arteries. The posterior tibial nerve is in close relation with the artery throughout. It lies at first on its medial side, but crosses over to its lateral side and runs downwards to the heel. The artery is accompanied by two venæ comites which join those of the anterior tibial artery at the lower border of the popliteus muscle to form the popliteal vein.

The **branches** of the posterior tibial artery are: (1) The **peroneal**, always of considerable size, and sometimes even larger than the parent

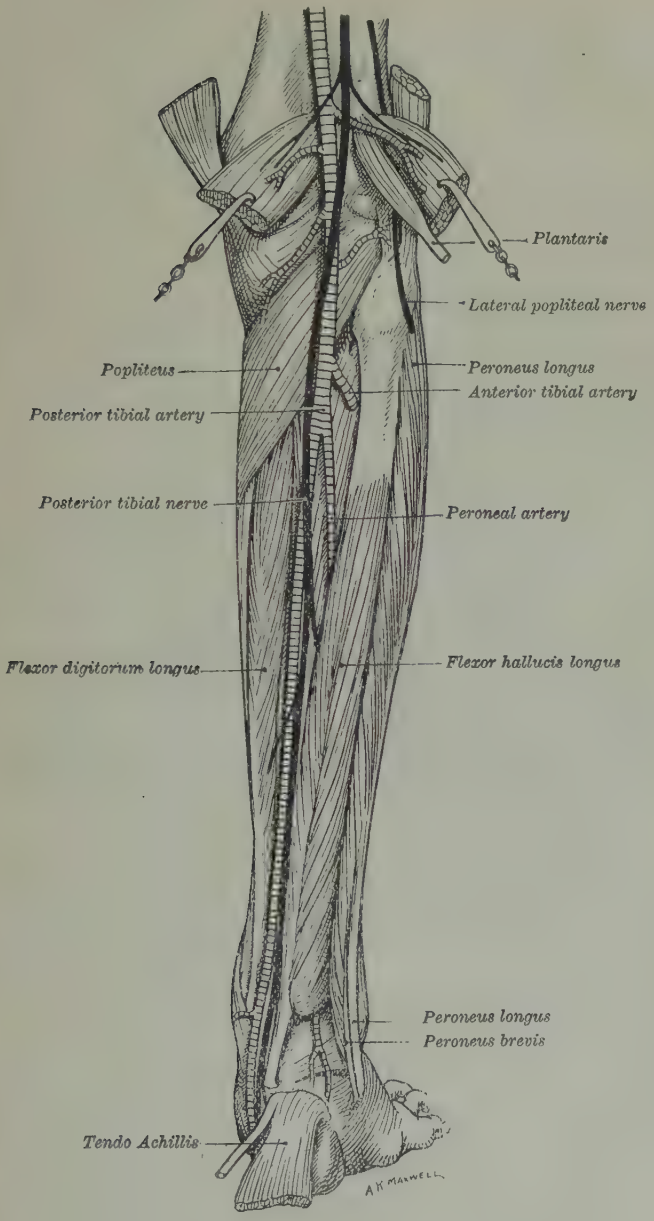


FIG. 48.

Deep dissection of the posterior tibio-fibular region.

vessel. It arises about two inches below the popliteus muscle, and runs downwards and laterally on the tibialis posterior. It soon afterwards enters the substance of the flexor hallucis longus, and under cover of its fibres runs downwards close to the medial border of the fibula to almost the lower end of that bone. It supplies the nutrient artery to the fibula, and is joined near the ankle by a communicating branch from the posterior tibial. It terminates by dividing into perforating and posterior malleolar branches. The former passes through the interosseous membrane to the front of the leg, where it has already been dissected, while the latter branch continues downwards behind the lateral malleolus and ends over the surface of the calcaneus in anastomoses with the neighbouring vessels. (2) **Muscular** branches to the deep muscles and to the soleus. (3) The **nutrient** artery to the tibia, which is of large size. It arises from the upper part of the posterior tibial, and enters the nutrient foramen with a direction towards the ankle joint. (4) A **communicating** branch, which runs transversely above the ankle and joins the peroneal artery. (5) A **medial calcanean** branch which arises beneath the annular ligament. It perforates that ligament and supplies the superficial structures on the medial side of the heel.

The **posterior tibial nerve** (Fig. 48) is the continuation from the popliteal space of the medial popliteal trunk, and passes with the artery of the same name beneath the soleus to lie on the deep muscles of the back of the leg. It is placed at first to the medial side of the artery, but crosses that vessel in its upper part and thereafter lies to its lateral side. This position it retains at the ankle, and with the artery passes under the annular ligament. The nerve there divides into medial and lateral plantar branches. The division of the nerve occurs at a higher level than that of the artery, and should it take place above the medial malleolus, the plantar nerves are usually found on either side of the vessel.

The posterior tibial nerve gives branches to the tibialis posterior, flexor digitorum longus, flexor hallucis longus, and soleus. Near the ankle it sends off a cutaneous branch, the **medial calcanean**, which pierces the medial annular ligament, and supplies the neighbouring skin of the heel and sole.

The **flexor digitorum longus** (Fig. 48) arises from the posterior surface of the tibia below the oblique line and medial to the attachment of the tibialis posterior, the separation between these muscles being indicated on the bone by an indistinct vertical ridge. The lowest fibres of the muscle reach to within three inches of the lower end of the tibia. Its tendon crosses to the lateral side of that of the tibialis posterior at the ankle, and passes beneath the medial annular ligament, and then into the sole of the foot. It will be seen in the dissection of that region to break up into four tendons, which are inserted into the terminal phalanges of the four lateral toes.

The **flexor hallucis longus** (Fig. 48) arises from the posterior surface of the fibula from below the origin of the soleus to within an inch of the ankle. At the ankle joint the tendon of the muscle lies on the back of the tibia to the lateral side of the posterior tibial vessels and nerve. It passes beneath the annular ligament, and winds into the sole of the foot in a groove on the posterior surface of the astragalus, and then beneath the sustentaculum tali. It is inserted on the terminal phalanx of the great toe.

The **tibialis posterior** (Fig. 48) is attached to both bones of the leg. It arises from the posterior surface of the tibia below the oblique line and lateral to the flexor digitorum longus, the origin extending to within two inches of the ankle; from nearly the whole length of the interosseous membrane; and from the whole of the medial surface of the fibula behind

the interosseous line. The fibres end in a tendon which, near the ankle, passes beneath, and then to the medial side of that of the flexor digitorum longus, and runs in a groove on the back of the medial malleolus and under the annular ligament into the sole of the foot. It is there inserted into the tubercle of the navicular bone, and by numerous slips into most of the other bones of the tarsus.

The Structures Behind the Medial Malleolus (Fig. 49).—The tendons of the deep group of the calf muscles, and the posterior tibial vessels and nerve, pass into the sole of the foot behind the

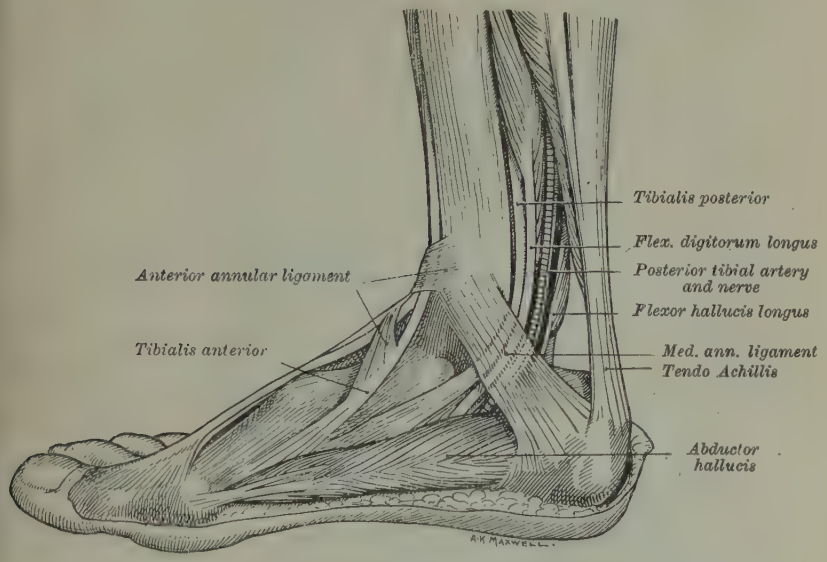


Fig. 49.
The structures in relation to the medial malleolus.

medial malleolus, and deep to the medial annular ligament. The whole surface of this ligament is to be exposed. As already described, it is a thickened part of the deep fascia of the leg, its upper border being continuous with the investing and subsoleal layers. It stretches between the medial malleolus and the posterior end of the calcaneus. The structures below it lie in the following order from the medial to the lateral side :—

1. Tendon of tibialis posterior.
2. Tendon of flexor digitorum longus.
3. Posterior tibial vessels.
4. Posterior tibial nerve.
5. Tendon of flexor hallucis longus.

The tendons are contained in separate compartments formed by septa passing from the deep surface of the ligament to the bones beneath. These compartments should now be opened up, and each with the contained tendon will be seen to be lined with synovial membrane.

THE SOLE OF THE FOOT

The foot is to be raised on a block so that the whole of the sole is conveniently disposed for dissection. An incision is to be made along the middle of the sole, as far as the bases of the toes, and there crossed by a transverse one, the knife in both cases being carried down to the glistening **plantar fascia** through the thick lobulated fat which lies beneath the skin. The skin and fat are to be reflected to each side, the knife being kept close to the fascia. Near the toes care must be taken to determine the division of the plantar fascia into slips passing to each digit, and the **plantar digital nerves** lying between the slips are to be secured at once. The nerves to the medial side of the great toe, and to the lateral side of the little toe, pierce the plantar fascia further back in the sole, and will be secured as the reflection of the skin and fat is continued. A lateral and medial set of minute vessels and nerves will be seen at the edges of the central part of the plantar fascia, and are to be divided without attempting to trace them out.

The plantar fascia is to be thoroughly cleaned, and the skin of the toes is to be laid open by a median incision in each.

The **plantar fascia** is divisible into three portions. The central, which is by far the strongest, is attached behind to the under surface of the lateral tuberosity of the calcaneus. It is narrow posteriorly, but as it passes forwards it expands to almost the whole breadth of the foot. At the bases of the toes it splits into five slips, connected together by distinct transverse fibres. Between the slips the plantar digital vessels and nerves become subcutaneous by emerging from below the fascia. Each slip of fascia is continued to one of the toes, in which it is attached to the sides of the proximal phalanx and to the fibrous sheath of the flexor tendons.

The marginal portions of the plantar fascia are much thinner, and are merely coverings of the muscles of the great and little toes. There is a strong band, however, on the lateral side of the foot, attached to the calcaneus and to the base of the fifth metatarsal bone.

The central part of the plantar fascia is to be divided near the heel and turned forwards so as to expose the **flexor digitorum brevis**, many of whose fibres are attached to the deep surface of the fascia. The marginal portions of the fascia are also to be removed, and the muscles beneath them—the **abductor hallucis**

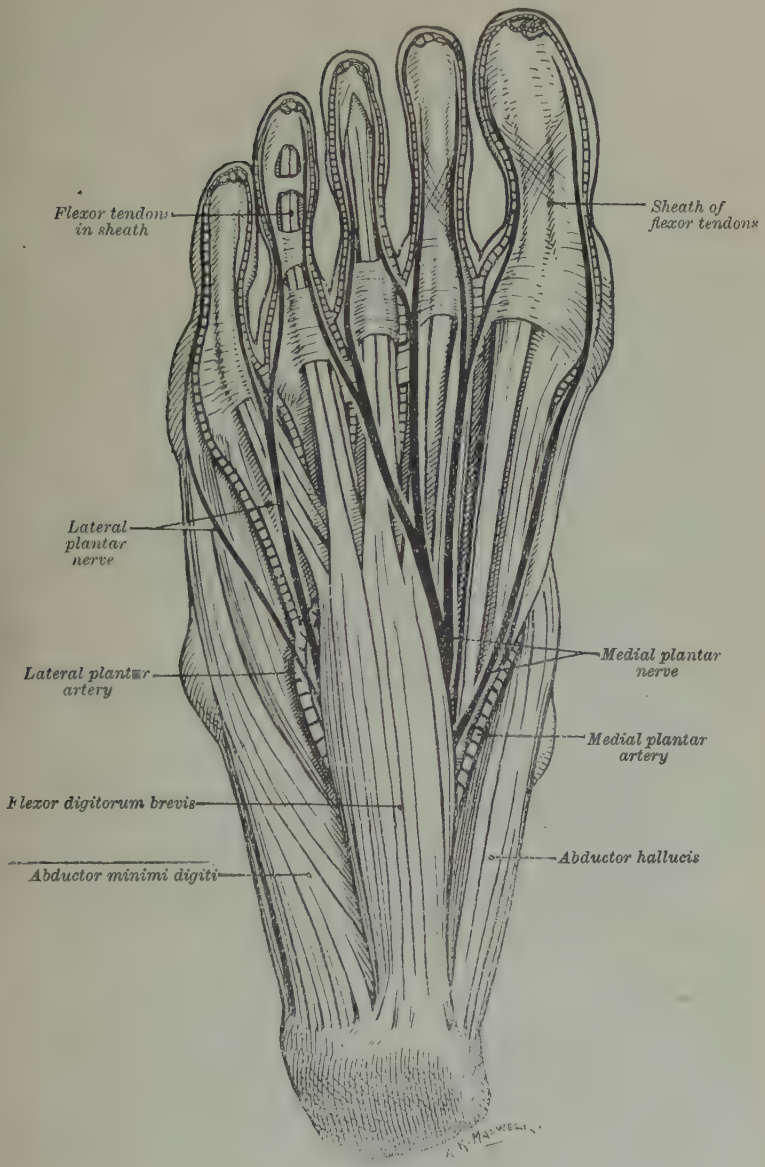


FIG. 50.

The first layer of the muscles of the sole and the plantar digital vessels and nerves.

on the lateral side and the **abductor minimi digiti** on the medial —are to be cleaned. These three muscles—constituting the first layer of the muscles of the sole—are separated from one another by intermuscular septa, and in the intervals between them the common trunks of the plantar digital nerves will be found.

The **abductor hallucis** (Fig. 50) arises from the medial tuberosity of the calcaneus and from the fasciæ in the neighbourhood. It is inserted by a broad tendon (which is joined by the medial head of the flexor hallucis brevis) into the medial side of the base of the first phalanx of the great toe, and it also sends an expansion dorsally to join the long extensor tendon of the digit.

The **abductor minimi digiti** (Fig. 50) arises from the lateral and medial tuberosities of the calcaneus in front of the flexor digitorum brevis and from the surrounding fascia. It is inserted into the lateral side of the base of the proximal phalanx of the little toe.

The **flexor digitorum brevis** (Fig. 50) arises from the medial tuberosity of the calcaneus, and from the central part of the plantar fascia, which covers it. Anteriorly it divides into four tendons, which pass into the tendon sheaths of the four lateral toes, each accompanied by the corresponding tendon of the flexor digitorum longus. The tendon of the flexor brevis to the little toe is very often a mere thread and is not infrequently wanting.

The flexor digitorum brevis is to be divided near its origin and turned forwards. Its nerve, from the **medial plantar**, is to be secured entering its deep surface and traced to its parent trunk. The second layer of the muscles of the sole will be brought into view, and emerging from under the abductor hallucis, and lying superficial to them, will be seen the **medial** and the **lateral plantar vessels** and **nerves**. The abductor hallucis is then to be divided near its origin and turned forwards, and the continuity of the plantar and the posterior tibial vessels and nerves is to be displayed.

The tendon of the **flexor digitorum longus** is to be followed forwards from the sustentaculum tali, where it lies to the medial side of the tibial vessels and nerve. It passes beneath the plantar vessels and nerves, and crosses over the tendon of the **flexor hallucis longus**, which is connected to it by a tendinous slip. About the centre of the foot it receives on its deep surface the insertion of a fleshy mass, the **musculus accessorius**, and then divides into four tendons, to which are attached the small fleshy bellies of the **lumbricales** muscles. These tendons and muscles—the second layer of the sole—are now to be cleaned and followed to their insertions. It will be necessary to slit open the fibrous tendon sheaths of the toes.

Insertion of the Flexor Tendons of the Toes (Fig. 51).—Two tendons, one from the flexor longus and one from the flexor brevis, enter the

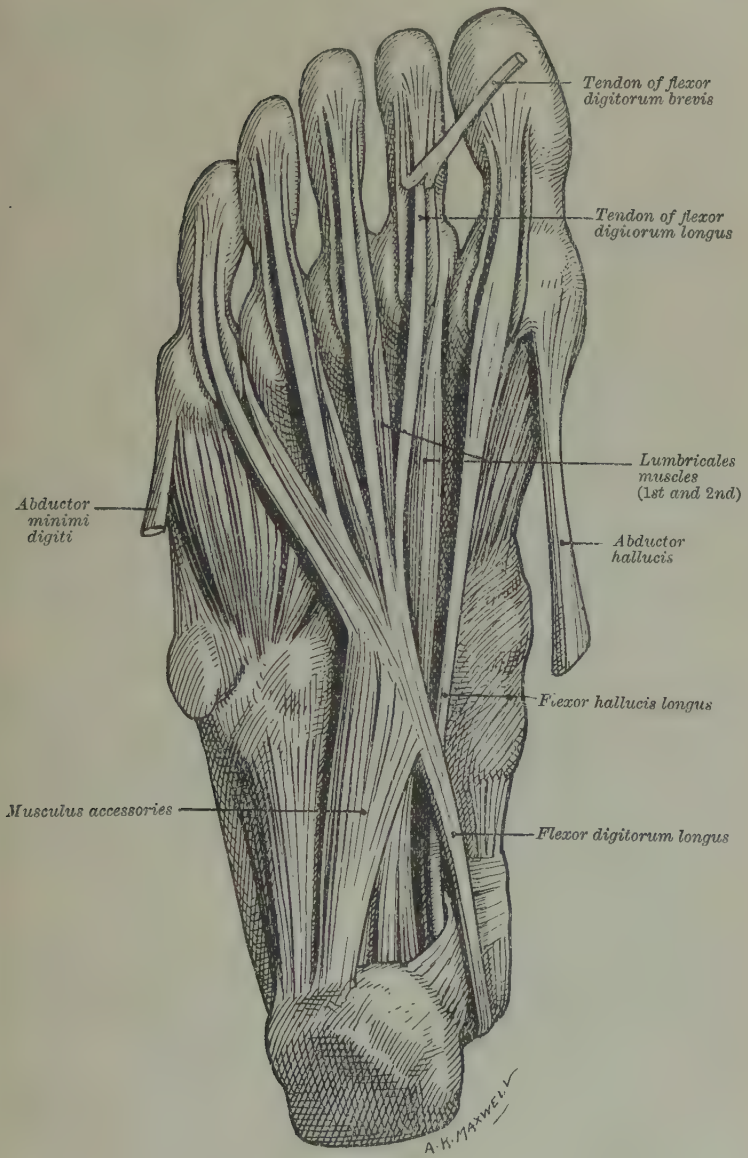


FIG. 51.

The muscles of the second layer of the sole.

tendon sheath of each of the four lateral toes. Each sheath is formed by the first and second phalanges of the toes, and by a fibrous arch covering the tendons, and attached to the lateral margins of the phalanges. This arch is strong opposite each phalanx, but thin over the related joints, and does not, therefore, impede their movements. When opened, the sheath will be seen to be lined by a synovial membrane which is reflected over the contained tendons. The tendon of the flexor brevis lies at first superficial to that of the flexor longus. It divides into two slips, which are inserted into the sides of the second phalanx. The tendon of the flexor longus passes between these slips and runs onwards to reach its insertion on the base of the terminal phalanx.

The tendon of the **flexor hallucis longus** runs forwards below the plantar vessels and nerves, and is crossed by the undivided tendon of the flexor digitorum longus, to which it gives a slip. It then runs between the two heads of the flexor hallucis brevis and the sesamoid bones related to them, and passing through a weak tendon sheath is inserted into the base of the terminal phalanx of the great toe.

The **musculus accessorius** (quadratus plantæ) (Fig. 51) arises from the plantar surface of the calcaneus by two heads (between which lies the long plantar ligament), and is inserted into the deep surface of the tendon of the flexor digitorum longus.

The **lumbricales** (Fig. 51) are four small "worm-like" muscles arising from the tendons of the flexor digitorum longus. The most medial muscle is attached to one tendon, the others to two tendons each. They wind round the medial side of the four lateral toes to reach their dorsal aspects, where they are inserted into the bases of the proximal phalanges, and have, as a rule, but little attachment to the extensor tendons, as is the case in the hand.

The bifurcation of the posterior tibial artery and nerve into their medial and lateral plantar branches is to be defined, and the plantar vessels and nerves have to be followed forwards from their origin. They enter the sole under cover of the abductor hallucis, and run forwards between the first and second layers of muscles, the lateral set reaching their position by crossing obliquely over the musculus accessorius. The arteries are accompanied by venæ comites.

The **medial plantar artery** is of small size and runs forwards in the interval between the abductor hallucis and the flexor digitorum brevis to the medial side of the great toe.

The **lateral plantar artery** (Fig. 52) is much larger. It runs obliquely across the sole between the flexor digitorum brevis and the accessorius muscle, and then forwards for a short distance in the interval between the flexor digitorum brevis and the abductor minimi digiti. It gives off a few small branches to the lateral side of the sole, and then turning round the lateral tendon of the flexor digitorum longus, disappears beneath the flexor tendons. It will afterwards be found to complete "the plantar arch" of the foot.

The **medial plantar nerve** (Fig. 52) is the larger of the branches of the posterior tibial, and accompanies the medial plantar artery. It supplies small cutaneous twigs to the sole, and muscular branches to the abductor hallucis and flexor digitorum brevis. It then breaks into four plantar

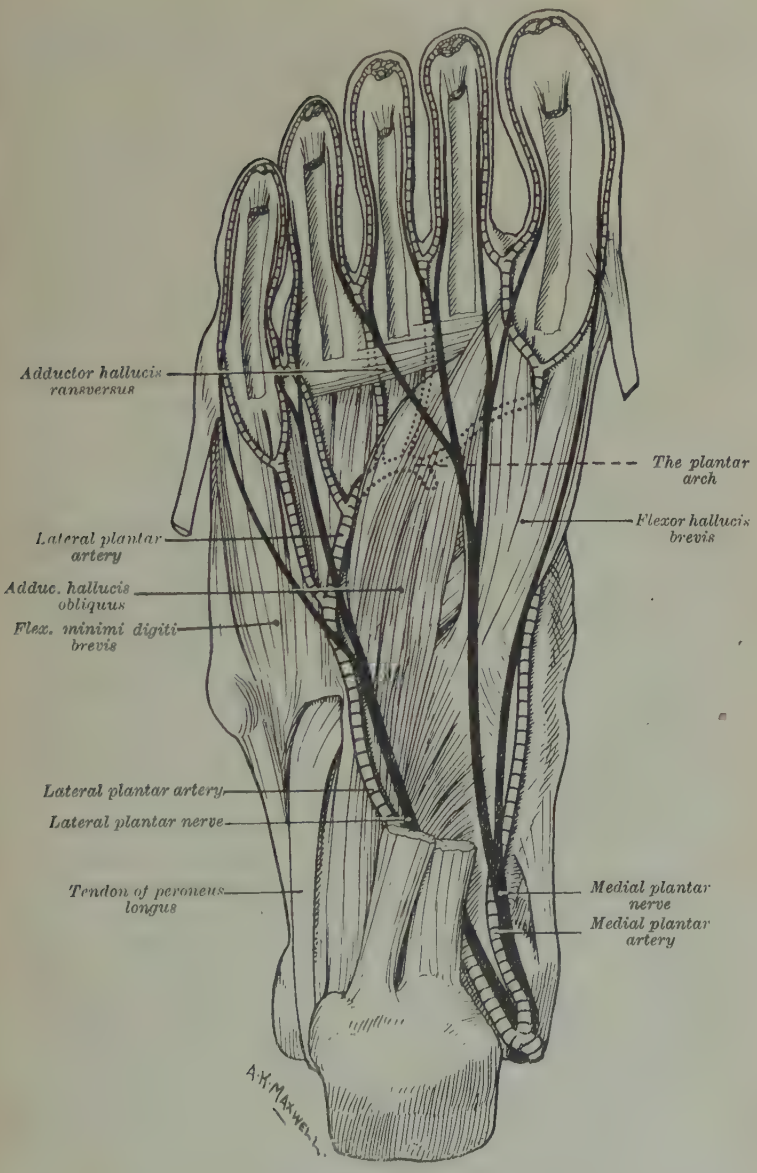


FIG. 52.

The vessels and nerves of the sole of the foot and the muscles of the third layer.

digital nerves, supplying respectively the medial side of the great toe and the adjacent sides of the great and second, second and third, and third and fourth toes. The branch to the medial side of the great toe gives off a twig to the flexor hallucis brevis—a muscle of the third layer—and the next digital branch supplies the first lumbrical muscle.

The **lateral plantar nerve** (Fig. 52) crosses the sole with the lateral plantar artery, giving branches to the accessorius and abductor minimi digiti muscles in its course. At the lateral border of the accessorius it divides into superficial and deep divisions, the latter accompanying the lateral plantar artery below the flexor tendons. The superficial division gives cutaneous branches to the lateral part of the sole and divides into two plantar digital nerves, one to the lateral side of the little toe, and the other bifurcating to supply the adjacent sides of the little and fourth toes, and usually communicating with the medial plantar nerve. The lateral digital branch supplies a twig to the flexor minimi digiti brevis and usually also the interossei muscles of the fourth space.

The tendons of the flexor digitorum longus and flexor hallucis longus, and the posterior tibial artery and nerve are to be divided at the ankle, and the musculus accessorius is to be separated from its origin. These structures are then to be turned forwards so as to display the third layer of the muscles of the sole, which are to be cleaned. The **plantar arch**, formed in part by the deep terminal portion of the lateral plantar artery, and the deep division of the lateral plantar nerve, will also be brought into view, and the branches from this nerve to the lateral three lumbrical muscles should now be secured. The other branches of the same nerve, which are distributed to certain of the muscles of the third and fourth layers of the sole, should also be sought.

Of the muscles of the third layer, the **flexor hallucis brevis** is that next to the abductor hallucis, and may be distinguished by its insertion by two heads, connected with which are the two sesamoid bones of the ball of the toe. The medial head is inserted with the abductor hallucis, and the lateral head in common with the two parts, the oblique and the transverse, of the **adductor hallucis**. The **flexor minimi digiti brevis** will be found medial to the abductor of that toe, and though inserted in common with it is easily distinguished by its origin from the fifth metacarpal bone.

The **flexor hallucis brevis** (Fig. 52) arises by a narrow tendon from the medial side of the cuboid bone, and is also attached to the adjacent part of the tendon of the tibialis posterior. Its fibres separate into two heads, which diverge from each other over the head of the metatarsal bone, and are inserted into the opposite sides of the base of the first phalanx of the great toe with the abductor and adductor muscles respectively. Each head has developed in its tendon a large sesamoid bone.

The **adductor hallucis** (Fig. 52) consists of two separate parts, the **obliquus** and the **transversus**. The obliquus portion arises from the bases

of the second, third, and fourth metatarsal bones, and from the sheath of the peroneus longus tendon ; and the transversus portion, of variable size, consists of three or four small bundles arising from the ligaments over the heads of the same bones. Both parts are inserted together, and in common with the lateral head of the flexor hallucis brevis, into the lateral (fibular) side of the base of the first phalanx of the great toe.

The **flexor minimi digiti brevis** (Fig. 52) arises from the base of the fifth metatarsal bone, and from the sheath of the peroneus longus tendon. It is inserted, in common with the abductor minimi digiti, into the lateral side of the base of the first phalanx of the little toe.

The **deep division** of the **lateral plantar nerve** crosses the sole of the foot in company with the plantar arch, and terminates in the deep surface of the adductor hallucis obliquus, which it supplies. It gives off branches to the lateral three lumbrical muscles (though the second lumbrical is often supplied by the medial plantar), to the adductor hallucis transversus, and to all the interossei muscles, except perhaps those of the fourth space, which may be supplied by the superficial division of the nerve.

The flexor hallucis brevis and the adductor hallucis obliquus are now to be divided and turned forwards, so as to obtain a complete view of the **plantar arch**. The four **digital** branches which arise from the anterior part of the arch are to be traced forwards to the lateral side of the little toe, and to the three lateral interdigital spaces, while in the first space the **arteria princeps hallucis**, arising from the termination of the **dorsalis pedis** artery in the sole, is to be secured. It supplies the adjacent sides of the great and second toes and the medial side of the great toe. The plantar **interossei** muscles are also fully exposed, and are to be defined.

The **plantar arch** (Fig. 52).—The **lateral plantar** artery, after turning round the lateral border of the flexor digitorum longus, passes medialwards across the sole. It rests on the plantar interossei muscles, and is successively under cover of the flexor tendons, the adductor hallucis obliquus, and the flexor hallucis brevis. This deep part of the artery has been termed the "plantar arch." It is closed on the medial side of the foot by inosculating with the terminal part of the dorsalis pedis artery, which enters the sole between the bases of the first and second metatarsal bones. Accompanying the arch there are two venæ comites. The plantar arch gives off (1) three **posterior perforating** arteries, which pass through the second, third, and fourth interosseous spaces, and anastomose with the interosseous arteries on the dorsum of the foot. (2) Four **digital** arteries distributed, as already mentioned, to the sides of the lateral three and a half toes. The digital arteries run on the sides of the toes with the digital nerves, and terminate in a plexus in the nail bed of the terminal phalanx. At the roots of the toes they are connected by anterior perforating vessels with the dorsal digital vessels.

The fourth layer of muscles of the sole comprises the tendons of the **peroneus longus** and **tibialis posterior**, and the **plantar** and **dorsal interossei** muscles.

The adductor hallucis transversus is to be detached from its origin and traced towards the great toe, and the flexor minimi digiti brevis is also to be reflected. Beneath the adductor transversus muscle there will be seen the **plantar transverse metatarsal ligament** from which its fibres arise, and over which the plantar digital vessels and nerves pass. This ligament must be divided between the heads of the several metatarsal bones, so that the toes may be separated from each other, and the interossei muscles traced to their insertions.

The **interossei** muscles are seven in number, three **plantar** and four **dorsal**. The plantar muscles are to be seen only from the sole, since they lie more or less on the under surface of the metatarsal bones, but the dorsal, being placed between the bones, are to be seen and dissected from both surfaces of the foot.

The **plantar transverse metatarsal ligament** is a strong fibrous band which connects the heads of all the metatarsal bones together, being attached to the plantar ligaments of the metatarso-phalangeal articulations. There is a much weaker **dorsal** ligament of the same name joining the dorsal aspects of the heads of the metatarsal bones, and between the two ligaments pass the tendons of the interossei muscles.

The three **plantar interossei** arise from the plantar aspects of the third, fourth, and fifth metatarsal bones, and are inserted into the medial sides of the first phalanges of the same toes and into the extensor tendons on their dorsal aspects. They thus act as adductors towards the second toe. The principal uses of both dorsal and plantar interossei are, however, to flex the proximal and extend the middle and terminal phalanges of the toes.

The four **dorsal interossei** occupy the four intermetatarsal spaces. Each muscle arises from the metatarsal bones bounding the space by two heads which are attached to almost the whole length of the shafts of the bones. They are inserted in such a manner as to act as abductors of the second, third, and fourth toes from a line prolonged through the second metatarsal bone. The first muscle is inserted on the medial side of the second toe, and the succeeding muscles on the lateral sides of the second, third, and fourth toes, the attachments in all cases being into the bases of the proximal phalanges and into the extensor tendons.

The tendon of the **tibialis posterior** (Fig. 59) passes into the sole from the medial side and reaches the tubercle of the navicular bone which is its main insertion. Fibrous expansions, however, are given off from the tendon to all the other bones of the tarsus except the astragalus, and also to the bases of the second, third, and fourth metatarsals. Where it passes under the head of the astragalus, the tendon has usually developed in it a sesamoid cartilage or bone.

The tendon of the **peroneus longus** has already been followed into the groove on the under surface of the cuboid bone. It runs from there medialwards across the sole to be inserted on the base of the first metatarsal and the adjacent part of the first cuneiform bone, but in its passage is enclosed in a fibrous sheath. This sheath, which is derived mainly from the long plantar ligament, is to be opened, and the synovial membrane which lines it will be seen.

The dissection of the sole of the foot will be completed by disarticulating the first metatarsal bone, so as to demonstrate the continuity of the dorsalis pedis artery with the plantar arch through the first interosseous space. In the three lateral interosseous spaces the posterior perforating branches of the plantar arch are to be followed to their junction with the dorsal interosseous digital vessels, and in each space the anterior perforating artery is to be looked for.

THE KNEE JOINT

(If the ligaments of the joints have become dry and hard, the limb should be soaked in water over-night.)

The vascular anastomoses on the sides and anterior aspect of the knee joint between the **articular** branches of the popliteal artery, the **anastomotica** of the femoral, and the **recurrent** branch of the anterior tibial are to be revised. These vessels form three transverse arches over the front of the joint, the uppermost lying along the upper margin of the patella, and the middle and lower arches being placed under cover of the ligamentum patellæ. All three arches are joined together by ascending and descending branches, and from the arcades thus formed branches are given off to the capsule and to the patella. The **azygos** articular artery perforates the posterior part of the capsule and supplies the intra-articular ligaments and extra-synovial fatty tissue.

The insertions of the muscles round the knee are also to be carefully studied. The hamstring muscles and the sartorius, gracilis, and both heads of the gastrocnemius are to be followed to their precise attachments, and then cut short, care being taken in the case of the biceps not to injure the **fibular collateral ligament**, which splits its insertion into two parts. The ligamentum patellæ is to be clearly defined, but without separating those parts of the vasti muscles which are attached to it.

The **bursæ** about the knee are then to be examined in considerable detail as regards their position and extent, since they are particularly liable to inflammation, which may be confused with inflammation of the joint.

The **bursæ** about the knee joint are (Fig. 53):—

1. The **prepatellar**, which lies on the surface of the patella under the covering of the fascia lata, and extends downwards for a short distance over the ligamentum patellæ. A second bursa is usually to be found superficial to the fascia lata over the patella, and the two as a rule communicate through that membrane.
2. The **infrapatellar** bursa lies deep to the ligamentum patellæ, and

intervenes between it and the upper part of the tibia. It may be explored by making a longitudinal incision in the ligament and turning its edges apart.

3. The **suprapatellar** bursa lies on the front of the femur under cover of the quadriceps extensor tendon. It communicates with the cavity of the knee joint by an opening of varying size, and is often regarded as a "suprapatellar pouch" of the synovial membrane of the joint. It should be exposed at present by making a longitudinal incision through the lower part of the crureus, and on to its walls the insertion of some of the deeper fibres of that muscle should be traced. These constitute the

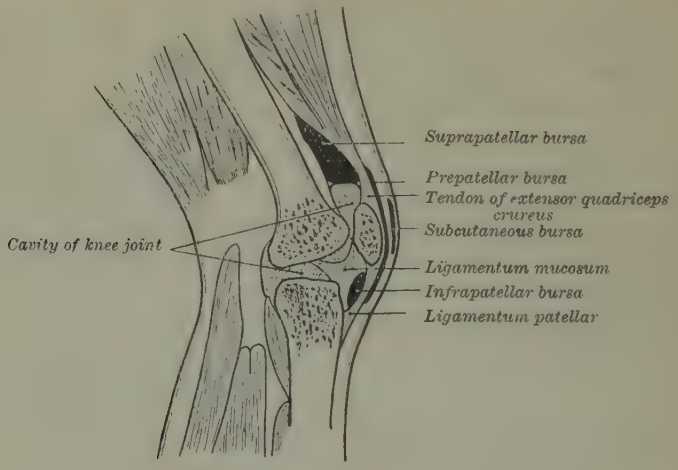


FIG. 53.

The synovial bursæ about the knee joint.

subcrureus muscle, the long slender nerve of which may be traced along the medial border of the crureus.

4. The **popliteus** bursa is an extrusion of the synovial membrane of the knee joint along the deep surface of the popliteus tendon, intervening between it and the tibial condyle.

5. Other bursæ have already been noted in connection with the attachments of the sartorius, semi-membranosus, biceps, and medial head of gastrocnemius.

The **articular capsule** of the knee is now to be examined. It is a fibrous investment of the joint but is deficient in front, its place being taken there by the quadriceps extensor tendon, the patella, and the ligamentum patellæ—these structures being sometimes referred to as the **anterior ligaments**. From these anterior structures the capsule proceeds backwards on each side, the fascia lata and aponeurotic expansions of the surrounding muscles, especi-

ally the vasti, entering largely into its formation. At the sides of the joint there are **tibial** and **fibular collateral** ligaments, the latter being covered by the capsule, but the former appearing incorporated with it. These ligaments are to be exposed and defined. The posterior part of the capsule is to be brought into view by cutting the tendon of the popliteus and turning the muscle downwards. It will be seen to be thin in its upper part, but to be strengthened below by the **oblique posterior** ligament, running

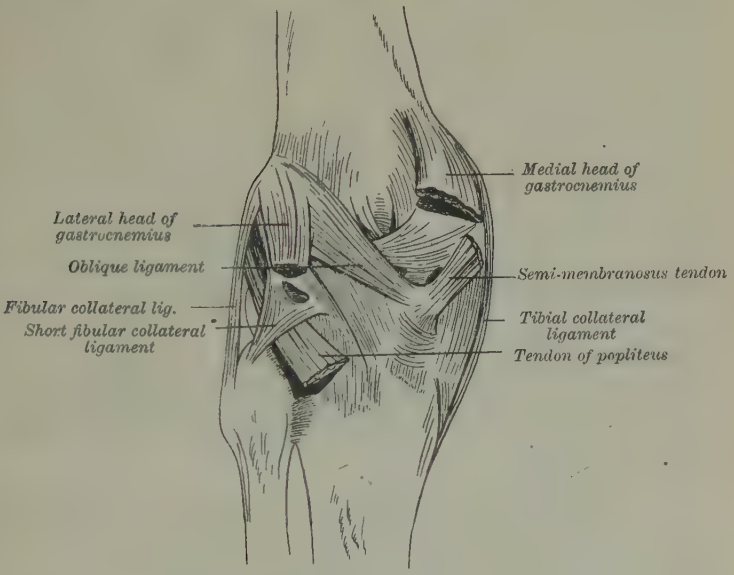


FIG. 54.

The capsule of the knee joint from behind and the related tendons. (After Quain.)

upwards and lateralwards, and derived in great part from the tendon of the semi-membranosus.

The anterior wall of the joint is to be defined by dissecting off the vasti and crureus muscles.

The **anterior ligaments** are represented by the patella and the ligamentum patellæ, to the margins of which are attached expansions of the vasti muscles, the so-called medial and lateral "patellar ligaments." It should be noted that the patellar attachment of the vastus medialis reaches to a lower level than that of the vastus lateralis, and that a process of the ilio-tibial band is, with the lateral muscle, attached to the margin of the patella and the ligamentum patellæ.

The **fibular collateral** ligament (Fig. 54), to be exposed by removing

the capsule covering it, is round and cord-like. It is attached above to the summit of the lateral tuberosity of the femur, immediately above the posterior end of the depression for the popliteus tendon, and below on the lateral side of the head of the fibula between the divisions of the biceps tendon. The tendon of the popliteus and the lateral inferior articular artery pass beneath it. A second ligament is sometimes described as the **short** fibular collateral ligament (lig. popliteum arcuatum). It lies behind the former band, and is attached to the femoral condyle above, and to the styloid process of the fibula below, and arches over the tendon of the popliteus muscle.

The **tibial collateral ligament** (Fig. 54) is a strong flat band closely connected with the medial part of the capsule, and previously seen to be covered by the tendons of the sartorius, gracilis, and semi-tendinosus. It is attached to the prominent part of the medial tuberosity of the femur just below the adductor tubercle, and expanding as it descends, may be divided into two portions, anterior and posterior. The posterior part is attached to the medial tuberosity of the tibia, and covers over the tendon of the semi-membranosus, while the anterior part is continued on to the upper part of the medial surface of the shaft of the tibia. There is an interval between the two parts, through which pass the inferior medial articular vessels of the knee.

The **posterior** part of the capsule (Fig. 54) stretches between the tibial and fibular collateral ligaments. It is attached above to the upper part of the intercondylar notch, on either side of which it is extremely thin, and closely connected with the heads of the gastrocnemius muscle; frequently it is perforated below the medial head of the muscle, and then the joint cavity communicates with the bursa which lies there. Below it is fixed to the back of the upper end of the tibia. It is strengthened by the **oblique posterior ligament**, a strong flat band of fibres which passes obliquely upwards and lateralwards, and is derived from the tendon of the semi-membranosus. The azygos articular artery perforates this part of the capsule, and a second opening in its lateral part gives exit to the tendon of the popliteus.

A vertical incision is to be made on either side of the patella and ligamentum patellæ, and the quadriceps extensor tendon is to be divided transversely. The "anterior ligaments" may now be thrown distally, so that the joint is open from the front, and the parts in its interior are displayed. A large **infrapatellar pad** of fat will be seen on the deep surface of the ligamentum patellæ. It occupies and adapts itself to the varying interval which would otherwise exist between the patella, femur, and tibia, during the movements of the joint. From its upper end a band of synovial membrane, the **ligamentum mucosum**, passes upwards and backwards to be attached on the back of the femur between the condyles. The upper part of this synovial band is narrow, but the lower part is broad, and its free expanded edges, which lie along the margins of the patella, are termed the **ligamenta alaria**. The ligamentum mucosum is to be divided, and the patella turned completely downwards. The intra-articular ligaments, the two **cruciate** and the

transverse, and the anterior parts of the two **semilunar cartilages** are now to be seen, and the extent and relations of the **synovial membrane** may be studied.

The **synovial membrane** of the knee joint is the most extensive of its kind in the body. It lines the deep surface of the capsule and its ligamentous structures, with the exception of the articular surface of the patella, and has already been seen to form the ligamentum mucosum and ligamenta alaria. It gives a tubular investment to the tendon of the popliteus while it lies within the capsule, and is reflected from the posterior wall of the capsule over the cruciate ligaments. This reflection forms a partial medial septum attached to the capsule behind, and

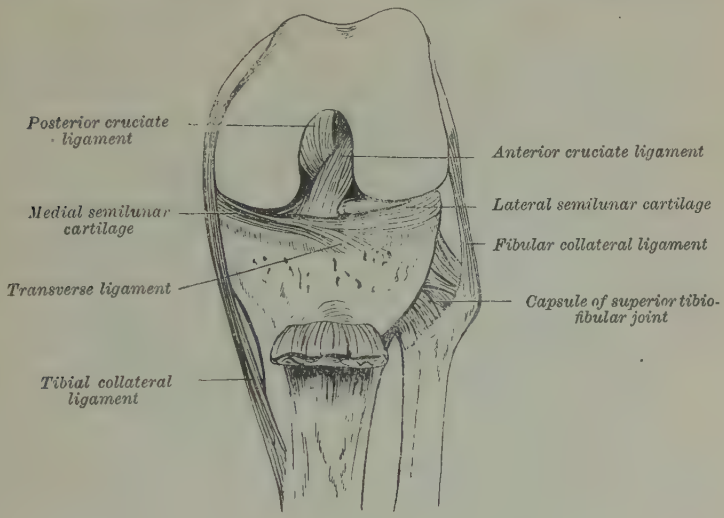


FIG. 55.

The knee joint (flexed) opened from the front. (After Quain.)

divides the back part of the joint cavity into lateral halves. These communicate with one another in front, but in rare cases the septum is complete. From the cruciate ligaments the synovial membrane is continued on to the upper and lower surfaces of the semilunar cartilages. From the capsular attachments to the bones it is reflected on the femur and tibia as far as their articular margins, but extends upwards on the front of the femur for at least one and a half inches, forming a pouch beneath the quadriceps tendon. This has already been seen to communicate (usually) with the suprapatellar bursa.

The **infrapatellar** bursa, between the ligamentum patellæ and the anterior tuberosity of the tibia, may be re-examined.

The posterior part of the capsule is now to be removed and the azygos artery traced forwards to the cruciate ligaments. These ligaments have now to be cleaned of their synovial membrane

investment, and the differences in their tension in different positions of the joint are to be studied. Their attachments are to be seen best by dividing the femur about three inches above its lower end, and in that part making a vertical median incision so as to divide it into lateral halves. The femoral condyles may now be turned aside from one another. It will be noted at once that the fibular collateral and the anterior cruciate ligaments form a pair related with the lateral condyle, to either side of which they are attached, and that the tibial collateral and posterior cruciate ligaments are similarly related to the medial condyle.

The **anterior cruciate ligament** (Fig. 55) is attached above in the intercondylar notch to the posterior part of the medial surface of the lateral condyle of the femur, and passes obliquely downwards, forwards, and medialwards across the joint. It is inserted into the non-articular area on the top of the tibia, immediately in front of the spine, and between the anterior attachments of the medial and lateral semilunar cartilages.

The **posterior cruciate ligament** (Fig. 55) is broader than the anterior. It is attached to the anterior part of the lateral surface of the medial condyle, and passes downwards, backwards, and slightly laterally to the top of the tibia, to which it is fixed between the articular facets and behind the spine and the posterior horns of both semilunar cartilages. It receives two fibrous slips from the posterior extremity of the lateral semilunar cartilage.

The **transverse ligament** (Fig. 55) is a small band connecting the anterior extremities of the semilunar cartilages across the middle line. It is often not distinct.

The collateral and the cruciate ligaments are to be divided close to their femoral attachments, so that the condyles of the femur may be removed. The **semilunar cartilages** are fully exposed, and are to be examined in considerable detail.

The **semilunar cartilages** (Fig. 56) are two crescentic fibro-cartilaginous plates which lie on the condylar surfaces of the tibia. They serve to deepen the tibial surfaces, forming for each femoral condyle a shallow socket, and are capable of change in shape and position in adaptation to the varying interval between the opposed articular surfaces of the bones during the movements of the joint. The circumference of each cartilage is the thickest part, and is attached to the internal surface of the capsule (the connecting fibres being known as the "coronary ligament"), and follows more or less the curvature of the margin of the corresponding tibial condyle. In the opposite direction the cartilages thin away to a free concave edge, and leave parts of the condylar surfaces of the tibia uncovered. The anterior and posterior extremities, or horns, of the cartilages are fibrous, and are attached to the rough inter-articular area on the top of the tibia. Both surfaces of the cartilages, the superior and inferior, are free, and are covered by synovial membrane.

The **medial cartilage** (Fig. 56) is oval in form. Its anterior extremity is attached to the tibia in front of the anterior cruciate ligament, its posterior extremity in front of the posterior cruciate ligament. Its circumference is closely connected with the tibial collateral ligament, and

on this account, and from its closer attachment to the tibial margin, it is less movable than the lateral cartilage. It is the more liable, however, to displacement by injury.

The **lateral semilunar cartilage** (Fig. 56) is nearly circular. Its anterior extremity is attached to the tibia immediately in front of the spine, its posterior extremity behind the spine. It is somewhat broader than the medial cartilage. The fibular collateral ligament is not in contact with its circumference, being separated from it by the tendon of the popliteus, and, as is implied above, it is more movable than the medial cartilage.

The **structures attached** to the intermediate non-articular area on the top of the tibia (Fig. 56) are as follows, from before back-

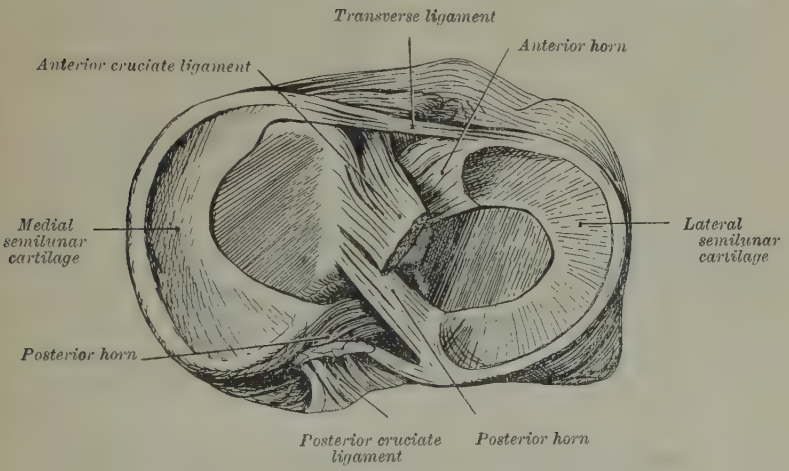


FIG. 56.

The structures on the upper surface of the tibia.

wards: (1) The transverse ligament. (2) The anterior extremity of the medial semilunar cartilage. (3) The anterior cruciate ligament. (4) The anterior extremity of the lateral semilunar cartilage. (5) The posterior extremity of the lateral semilunar cartilage, separated from the anterior extremity by the tibial spine. (6) The posterior extremity of the medial semilunar cartilage. (7) The posterior cruciate ligament.

THE ANKLE JOINT

The bones which enter into the formation of the ankle joint are the lower ends of the tibia and fibula, and the upper surface and sides of the astragalus, the leg bones being firmly united together by interosseous ligaments.

Clean away all the muscular fibres connected with the bones of the leg and foot, leaving, however, the tendinous insertions about the foot to be examined with the ligaments. The remains of the annular ligaments should also be removed, and the **articular capsule** of the ankle joint is to be examined. The **anterior** and **posterior** parts of this capsule are thin, and can hardly be described as ligaments, but there are strong **collateral ligaments** spreading out

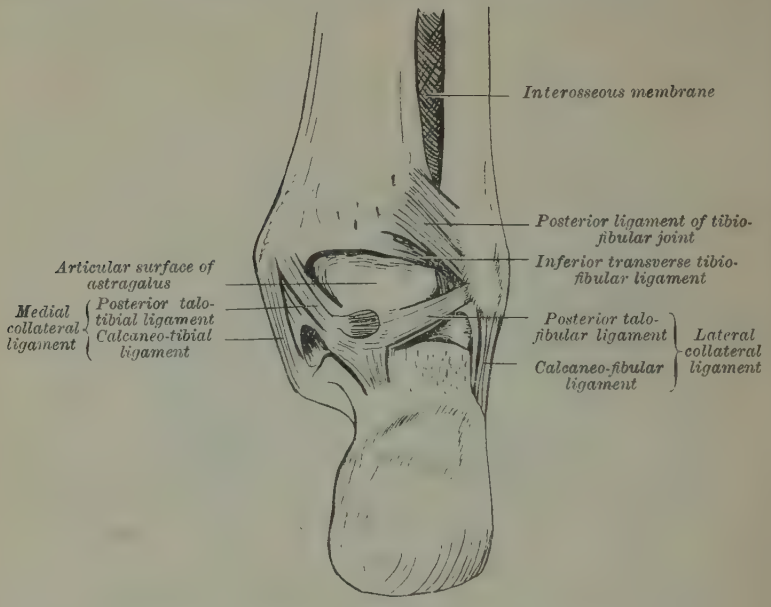


FIG. 57.

The ligaments of the ankle joint from behind. (After Quain.)

below on the tarsal bones from their upper attachments to the tibial and fibular malleoli. They are to be brought into relief by removing the anterior and posterior parts of the capsule.

The **anterior** and **posterior** parts of the capsule are broad, thin membranes, which are seldom seen in their entirety, as they are liable to be dissected away. They are attached to the margins of the articulating surfaces, and their fibres have, for the most part, a transverse direction between the collateral bands.

The **medial collateral ligament** (ligamentum deltoideum) is triangular in shape. The apex is attached near the tip of the medial malleolus, and the fibres, diverging as they descend, are attached as a continuous layer to the posterior part of the astragalus, the sustentaculum tali, the inferior calcaneo-navicular ligament, and the tuberosity of the navicular bone. A

strong, **deep portion** of the ligament passes from the apex of the malleolus to the side of the astragalus.

The **lateral collateral ligament** consists of three separate fasciculi—an anterior, a middle, and a posterior. The anterior band (anterior talo-fibular) runs from the anterior border of the fibular malleolus to the side of the neck of the astragalus. The middle band (calcaneo-fibular) is round and cord-like, and passes downwards and backwards from the tip of the malleolus to the lateral side of the calcaneus behind the peroneal tubercle. The posterior fasciculus (posterior talo-fibular) is the strongest, and is attached to the fossa behind the malleolar articular facet. It passes almost horizontally backwards to the lateral tubercle on the back of the astragalus.

The ligaments of the joint are to be divided so that the astragalus may be removed from its socket. Note that the synovial membrane sends a small diverticulum upwards between the tibia and fibula, and then examine the articular surfaces of the bones of the joint, observing particularly that the upper surface of the astragalus is broader in front than behind, since the lateral margin of the tibial articular surface is oblique while the medial margin is straight.

THE TIBIO-FIBULAR ARTICULATIONS

The bones of the leg articulate with one another at both their upper and lower ends, while their shafts are connected together throughout their lengths by the **interosseous membrane**. Examine this structure first, all the muscle fibres being removed from both its surfaces.

The **interosseous membrane** stretches between the lateral border of the tibia and the interosseous ridge on the medial surface of the fibula, its fibres running downwards from the tibia to the fibula. It affords an extended origin to the muscles of the leg. It is perforated by the anterior tibial vessels in its upper part, and a short distance above the ankle joint is pierced by the perforating peroneal artery.

The capsule of the **superior tibio-fibular** joint is strengthened in front and behind by anterior and posterior ligaments, short bands stretching between the bones. The tendon of the popliteus rests on the posterior ligament, and the popliteal bursa is frequently continuous with the synovial cavity of the joint.

The **inferior tibio-fibular** articulation is in greater part of the nature of a **syndesmosis**; that is, the opposed bony surfaces are not covered by articular cartilage, but are bound together by fibrous tissue. The surfaces, indeed, are somewhat rough, and the **interosseous ligament**, as the connecting fibres are termed, is of considerable strength. Below this syndesmosis, however, a narrow area at the lower end of each of the bones is covered by articular

cartilage, and a simple arthrodial joint is formed, which is continuous with the ankle joint. This joint has **anterior** and **posterior** ligaments, strong flat bands passing between the bones, and if the posterior of these is cut through the **inferior transverse** ligament will be seen. This band is also of considerable strength. It passes across the back of the joint and fills up the interval between the tibia and fibula, and forms part of the tibio-fibular socket for the astragalus, on the posterior part of the lateral margin of which there is a distinct triangular facet produced by contact with the ligament. A coronal section of the lower ends of the bones is an excellent method of displaying the inferior tibio-fibular joint and its related ligaments. These, it may be noted, are of such a strength that the bones are very rarely separated from one another by accident during life.

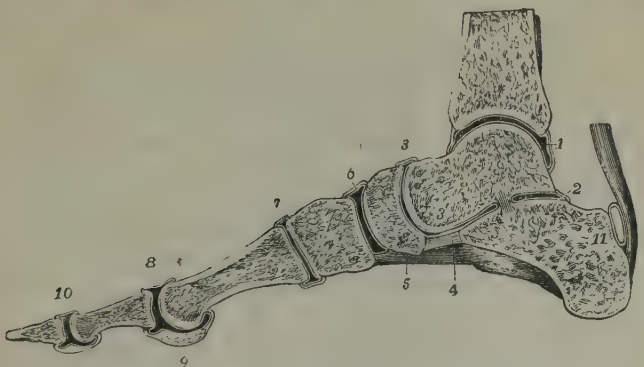
THE JOINTS OF THE FOOT

(The joints and ligaments of the foot are of great surgical importance, and the student must be at considerable pains to understand them properly. An articulated skeleton of the foot should be beside him throughout the dissection.)

The tarsal and metatarsal bones are arranged so as to form two arches—a longitudinal and a transverse—which are maintained in position partly by the requisite moulding of the articulating surfaces of the bones, partly by the ligaments which pass between the bones, and partly by the muscles which act on the foot. The astragalus, to which the weight of the body is transmitted, is the keystone of the longitudinal arch, and is supported on an anterior and a posterior bony pillar, the extremities of which are, respectively, the heads of the metatarsal bones and the heel. The posterior pillar is short, is considerably oblique, and is formed by the calcaneus alone. The anterior pillar is longer, is more horizontal, and consists of the remaining tarsal and all the metatarsal bones, but may be considered as being formed of lateral and medial columns. The medial column is the more important, and is of greater height and span than the lateral. It is composed of the navicular, the three cuneiform, and the three medial metatarsal bones. The lateral column is formed by the cuboid and the two lateral metatarsals. The ligaments which are concerned in maintaining the bones in position, and so assisting to preserve the arch against flattening, are on the plantar aspect, and pass between the anterior and posterior pillars under the keystone. They are the **inferior calcaneo-navicular** and the two **plantar calcaneo-cuboid** ligaments, and these are aided by

the various slips of the tibialis posterior muscle and by the plantar fascia. The transverse arch of the foot is most prominent in the region of the distal tarsal bones—the cuneiform and the cuboid—and related with the maintenance in position of this arch are **interosseous** ligaments which pass between the bones.

The Tarsal Joints.—The tarsal bones are connected together by **dorsal, plantar,** and **interosseous** ligaments. The dorsal bands are composed of short fibres passing between adjacent bones. They are of no great strength, and in most cases are thin and membranous.



1, cavity of ankle joint; 2, posterior talo-calcaneal articulation; 3, 3', talo-calcaneo-navicular articulation—the interosseous ligament is seen separating 2 from 3'; 4, plantar calcaneo-navicular ligament; 5, part of long plantar ligament; 6, cuneo-navicular ligament; 7, first cuneo-metatarsal articulation; 8, first metatarso-phalangeal articulation; 9, section of the medial sesamoid bone; 10, interphalangeal articulation; 11, placed on the calcaneus, indicates the bursa between the upper part of the tuberosity of that bone and the tendo Achillis.

FIG. 58.

Longitudinal section through the medial side of the foot.
(From Quain's "Anatomy.")

They should be cleaned at the present stage of the dissection, but it is not necessary that they should be defined individually.

The articulations of the astragalus with the calcaneus and navicular bones are to be examined first. The **dorsal astragalo-navicular** ligament is to be removed, and the **lateral** and **posterior astragalo-calcanean** ligaments are to be defined and then divided.

The **lateral** ligament is a short band running somewhat backwards from the lateral surface of the astragalus, below the malleolar facet, to the lateral surface of the calcaneus. The **posterior** ligament passes between the posterior parts of the two bones.

The joint between the posterior part of the under surface of the body of the astragalus, and the corresponding part of the upper surface of the calcaneus, can now be seen by cleaning away the

surrounding synovial membrane, but the socket for the head of the astragalus is best seen by the removal of the whole bone. This is somewhat difficult to accomplish, since it necessitates the division of the **interosseous astragalo-calcanean** ligament which is still binding the bones together.

The **interosseous** ligament is a strong thick band which fills the tarsal canal. It is attached to the grooves which are present on the opposed

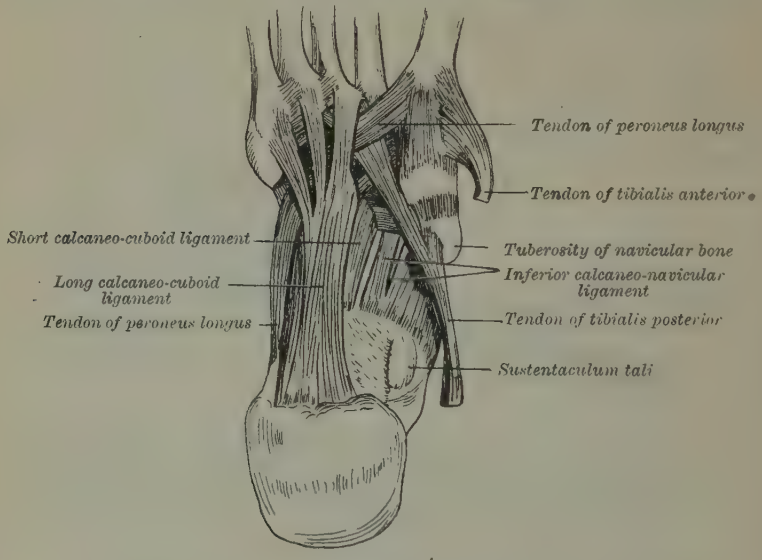


FIG. 59.

The ligaments of the sole of the foot and the related tendons. (After Quain.)

surfaces of the bones, and which separate the two articular areas of each bone from one another.

The interosseous ligament having been divided, the astragalus may be removed. The posterior astragalo-calcanean joint will be seen to be complete in itself, possessing its own synovial membrane, and to be cut off from the anterior joint by the interosseous ligament. The structures which form the socket for the head of the astragalus are now to be examined, and the markings on the head of the astragalus corresponding to them are to be identified. The socket is formed by the concave surface of the navicular bone in front, by the upper surface of the sustentaculum tali behind, and between these two by the **inferior calcaneo-navicular** ligament which connects

them together, and affords a support for a considerable area of the head of the astragalus. This socket will be seen to be closed (in most cases) laterally by the **lateral calcaneo-navicular** ligament.

The **inferior calcaneo-navicular** ligament is to be examined from both aspects of the foot. It is a broad elastic ligament which fills the interval between the sustentaculum tali and the navicular bone, and takes part in the formation of the socket for the head of the astragalus. It is attached behind to the anterior border of the sustentaculum tali, and in front to the posterior border and under surface of the navicular bone. It performs the important function of resisting the forcing downwards of the head of the astragalus by the weight of the body, and thus preserves, and at the same time secures an elasticity for, the medial part of the longitudinal arch of the foot. In this it is assisted by the tendon of the tibialis posterior muscle which crosses its under surface, and which must be completely removed to expose the ligament. The upper surface of the ligament is lined by the synovial membrane of the joint in which it takes part.

The **lateral calcaneo-navicular** ligament is composed of short fibres which pass between the anterior part of the calcaneus lateral to the sustentaculum tali, and the lateral surface of the navicular bone.

The dorsal **calcaneo-cuboid** ligament is now to be removed so as to open into the calcaneo-cuboid joint, which will be seen to be separated from the astragalo-navicular articulation by the lateral calcaneo-navicular ligament. The two joints taken together, however, are often referred to as the "transverse tarsal joint," and it is here, mainly in its medial component, however, that the movements of eversion and inversion of the foot take place. The calcaneo-cuboid joint is provided with a weak **medial calcaneo-cuboid** ligament closely connected with the lateral calcaneo-navicular, and with the two **plantar** ligaments joining the bones. These are of considerable strength, and second in importance only to the inferior calcaneo-navicular band in the maintenance of the longitudinal arch of the foot. They are superficial and deep in position and are to be dissected at present.

The **long calcaneo-cuboid** (or long plantar) ligament is a broad ligament which has already been seen in the dissection of the sole of the foot. It is attached to the under surface of the calcaneus in front of its tuberosities, and passes forwards to be fixed to the posterior margin of the peroneal groove in the cuboid bone. Some of its fibres, however, are continued forwards over the tendon of the peroneus longus (for which they form a sheath), and are attached to the bases of the second, third, and fourth metatarsal bones.

The **short calcaneo-cuboid** (or short plantar) ligament is more deeply placed, and lies to the medial side and under cover of the long ligament. Detach the long ligament from the calcaneus and turn it forwards, and the short band will be brought into view. It reaches from the anterior tubercle on the under surface of the calcaneus to the under aspect of the cuboid behind the groove.

The **navicular bone**, and the three **cuneiform** bones, are joined by dorsal and plantar ligaments, the latter being formed in main part by slips from the tibialis posterior tendon.

The **cuneiform** bones are connected together by weak dorsal and plantar **intercuneiform** ligaments, but they are held in position, with considerable firmness, by two **interosseous** ligaments. These pass between the non-articular parts of the opposed surfaces of the bones, and may be seen by separating them with the knife.

The articulation between the lateral **cuneiform** and the **cuboid** bones possesses dorsal, plantar, and interosseous ligaments, and a similar series binds together the navicular and cuboid. (In a few cases the navicular and cuboid bones may be found to articulate directly with one another.)

The **Tarso-metatarsal Joints.**—The bones of the metatarsus are connected with the distal row of tarsal bones by dorsal, plantar, and interosseous ligaments.

The **dorsal** ligaments are flat bands passing between each metatarsal and the tarsal bone with which it articulates, the second metatarsal, however, receiving additional slips from the medial and lateral cuneiform bones. The **plantar** ligaments are less regular, and are more or less connected with the calcaneo-cuboid ligament. Those in connection with the first and second metatarsal bones are the strongest.

The several tarso-metatarsal joints should be laid open by dividing their dorsal ligaments, and the metatarsus should be forcibly bent on the tarsus. The **interosseous** ligaments will be seen, and may be ruptured by continuing the movement. The student should then examine the articular relations between the individual metatarsal and tarsal bones.

The **interosseous** ligaments are short strong bands, usually three in number. The medial one passes between the inner cuneiform bone and the second metatarsal, and a second ligament, a weaker band, usually reaches the same metatarsal from the lateral cuneiform. The lateral ligament passes between the lateral cuneiform and the base of the third metatarsal.

The Intermetatarsal Joints.—The *bases* of the metatarsal bones, with the exception of the first, articulate with each other, and all are firmly bound together by dorsal, plantar, and interosseous ligaments. The *heads* of the bones were previously seen to be connected by the transverse metatarsal ligaments.

The Synovial Membranes of the Foot.—The tarsal, tarso-metatarsal, and intermetatarsal joints have in all six synovial

membranes, each of which forms the lining of a separate joint cavity. They are arranged as follows:—

1. That lining the posterior astragalo-calcanean joint.
2. That of the anterior astragalo-navicular-calcanean joint, inclusive of the two calcaneo-navicular ligaments.
3. That belonging to the calcaneo-cuboid articulation.
4. That common to the naviculo-cuneiform, intercuneiform, and cubo-cuneiform joints, and which also lines the second and third tarso-metatarsal and intermetatarsal joints between the second, third, and fourth bones.
5. That connected with the joint between the cuboid and the bases of the fourth and fifth metatarsals, and prolonged into the articulation between the latter bones.
6. That lining the joint between the first metatarsal and the medial cuneiform bone.

The **Metatarso-Phalangeal** and **Interphalangeal Joints.**—These joints are constructed on the same principle as the corresponding joints of the hand, and each is provided with similar ligaments—a plantar and two collateral. The dorsal part of the capsule of each joint is weak, and is closely adherent to the extensor tendon. The plantar ligament is dense and fibrous, and in that of the metatarso-phalangeal joint of the great toe there are two large sesamoid bones.

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